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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

No. 1777

DIRECT-READING DESIGN CHARTS FOR 24S-T ALUMINUM-ALLOY FLAT COMPRESSION PANELS HAVING LONGITUDINAL STRAIGHT-WEB Y-SECTION STIFFENERS

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DIRECT-READING DESIGN CHARTS FOR 24S-T ALUMINUM-ALLOY

FLAT COMPRESSION PANELS HAVING LONGITUDINAL

STRAIGHT-WEB Y-SECTION STIFFENERS

By Norris F. Dow, Ralph E. Hubka, and William M. Roberts

SUMMARY

Direct-reading design charts are presented for 24S-T aluminum-alloy flat compression panels having longitudinal straight-web Y-section stiffeners. These charts make possible the direct determination of the stress and all the panel proportions required to carry a given intensity of loading with a given skin thickness and effective length of panel.

INTRODUCTION

Design charts for wing compression panels have been presented in several different forms. (See references 1 and 2.) In reference 3, a form was developed which permitted the direct selection of proportions for given values of the principal design conditions - intensity of loading, skin thickness, and effective length of panel. This form also made possible the ready determination of the proportions having minimum weight to meet these conditions. The charts presented in reference 3 covered 75S-T aluminum-alloy flat compression panels having longitudinal straight-web Y-section stiffeners. Similar charts for 24S-T aluminum-alloy panels with formed Z-section stiffeners are presented in reference 4 and direct-reading design charts for 24S-T aluminum-alloy Y-stiffened panels are presented herein.

SYMBOLS

The symbols used for the panel dimensions are given in figure 1. In addition, the following symbols are used:

- c coefficient of end fixity as used in Euler column formula
- d rivet diameter, inches
- L length of panel, inches
- p rivet pitch, inches

P_1	compressive load per inch of panel width, kips per inch
r	all fillet radii, inches
\bar{t}	cross-sectional area per inch of panel width, expressed as an equivalent or average thickness, inches
ρ	radius of gyration, inches
$\bar{\sigma}_f$	average stress at failing load, ksi
σ_{cr}	stress for local buckling of sheet, ksi
σ_{cy}	compressive yield stress, ksi

DIRECT-READING DESIGN CHARTS

Direct-reading design charts for 24S-T aluminum-alloy flat compression panels with longitudinal straight-web Y-section stiffeners having the properties and proportions given in tables 1 to 6 are presented in two forms in figures 2 to 11. In the first form (figs. 2 to 6), the design conditions of intensity of loading, effective length of panel, and skin thickness are incorporated in the ordinate P_1/t_S and the abscissa $\frac{P_1}{L/\sqrt{c}}$. This form, having the design conditions incorporated in the ordinate and abscissa, is the more useful for most design purposes because the curves are more widely spaced and interpolation is more straightforward. In the second (alternate) form (figs. 7 to 11), the average stress at failure $\bar{\sigma}_f$ is plotted against P_1/t_S as was done in the summary plots of reference 5. This alternate form, having the stress — an inverse measure of weight for a given load — as ordinate, is the more useful for making generalizations and comparisons of structural efficiency because it shows how nearly the stress actually carried approaches the upper limit corresponding to the stress that would be achieved by a pure shell construction if a pure shell could carry the load without failure.

This upper limit of stress is represented by the lines for $\bar{\sigma}_f = \frac{P_1}{t_S}$ (infinite stiffener spacing) in figures 7 to 11.

Values of the ratios of stiffener thickness to skin thickness t_W/t_S , average spacing of rivet lines to skin thickness S/t_S (because there are two rivet lines associated with each Y-section, the stiffener spacing equals $2S$), and height of stiffener to stiffener thickness H/t_W , which will satisfy the design conditions, may be found directly from these charts, and the corresponding section properties \bar{t}/t_S , \bar{h}/t_S , and ρ/t_S may be found from tables 2 to 6. In the first form of design chart (figs. 2 to 6) dashed lines are used to indicate values of average

stress at failure $\bar{\sigma}_f$; whereas, on the alternate form of design chart (figs. 7 to 11) dashed lines are used to indicate values of $\frac{P_i}{L/\sqrt{c}}$. In

both forms the value of $\bar{\sigma}_f$ corresponding to the point at which each curve is cut by a short heavy line is the value of the stress for local buckling σ_{cr} for the proportions represented by the curve. For

example, the value of σ_{cr} for $\frac{H}{t_w} = 33.8$ and $\frac{S}{t_s} = 16.2$ in figure 2 is approximately 41.3 ksi. (Only a very short panel of these proportions would buckle before failure — one having a value of $\frac{P_i}{L/\sqrt{c}} \geq 0.60$.)

If the value of σ_{cr} is so low that the short heavy line would fall outside the boundaries of the chart, a numerical value of σ_{cr} is given and is associated with the proper proportions by a leader to the curve. The panel proportions which have minimum weight are indicated on both forms of these charts by the use of colors as follows:

(1) If the proportions correspond to a blue region, they are the proportions which give the lightest possible 24S-T Y-stiffened panel which will meet the design conditions

(2) If the proportions correspond to a red region, they are the lightest possible at the ratio of stiffener thickness to skin thickness given by that particular chart, but some other thickness ratio would give a lighter design

(3) If the proportions correspond to a white region, the proportions meet the design conditions, but they are not the lightest which will meet the conditions

Because in many cases the proportions may be varied somewhat from those indicated by the red and blue regions with little change in the value of the stress that can be carried, too much importance should not be attached to the exact proportions indicated by the colors to have minimum weight. In any particular case for which a deviation from the minimum-weight proportions is made, however, caution dictates that the weight penalty associated with this deviation be determined.

The direct-reading design charts presented herein were developed in the manner described in reference 3 from the test data and resulting curves given in reference 5.

USE OF THE DIRECT-READING DESIGN CHARTS

The manner of using the direct-reading design charts depends in some measure on the desired degree of precision of interpolation among the curves. For many purposes, interpolation by inspection is of adequate accuracy, and the use of the charts requires only the calculation

of the values of the design parameters P_i/t_S and $\frac{P_i}{L/\sqrt{c}}$ to permit the desired proportions to be read directly from the curves. The proportions for minimum weight, moreover, may be found directly as those corresponding to the blue region on the curves.

If more accurate interpolation is desired, a plot can readily be made of H/t_W , $\bar{\sigma}_f$, and σ_{cr} against S/t_S at the given values of P_i/t_S and $\frac{P_i}{L/\sqrt{c}}$ and the proportions can be picked from it. (This plot is similar to that which results from the use of the minimum-weight design procedure with the previously available design charts as illustrated in reference 2.) On a plot of this type, the proportions for minimum weight correspond to those associated with the highest value of $\bar{\sigma}_f$.

As a check on the accuracy of interpolation, the cross-sectional area per inch of width of the design may be determined from the values of \bar{t}/t_S given in tables 2 to 6 and the value of the intensity of loading P_i that can be carried on this cross-sectional area per inch at the value of $\bar{\sigma}_f$ given by the charts may then be compared with the design value of P_i .

ILLUSTRATIVE EXAMPLE

In order to illustrate the use of the direct-reading design charts and the simplicity of the computations associated with them, a panel will be designed for minimum weight to meet the same principal design conditions used to illustrate the design procedures in reference 2, namely:

1. Intensity of loading $P_i = 3.0$ kips per inch
2. Skin thickness $t_S = 0.064$ inch
3. Effective length $L/\sqrt{c} = 20$ inches

As was pointed out in reference 5, an intensity of loading as small as 3.0 kips per inch may require a stiffener thickness smaller than can be successfully extruded. The value of P_i of 3.0 kips per inch is retained for the example, however, in order to provide a ready comparison with the examples of reference 2.

First the values of P_1/t_S and $\frac{P_1}{L/\sqrt{c}}$ are calculated

$$\frac{P_1}{t_S} = \frac{3.0}{0.064}$$

$$= 46.9 \text{ ksi}$$

$$\frac{P_1}{L/\sqrt{c}} = \frac{3.0}{20/\sqrt{1}}$$

$$= 0.15 \text{ ksi}$$

Then a trial value of t_W/t_S is assumed (for the example $\frac{t_W}{t_S} = 0.51$ will be used). In the chart for this value of t_W/t_S (fig. 3) the points corresponding to the design values of P_1/t_S and $\frac{P_1}{L/\sqrt{c}}$ lie above the red line at $\frac{H}{t_W} \leq 44.6$ (or $\frac{b_W}{t_W} \leq 24$), below the red line at $\frac{H}{t_W} \geq 55.3$ (or $\frac{b_W}{t_W} \geq 30$), and very nearly on the red line at $\frac{H}{t_W} = 49.9$ (or $\frac{b_W}{t_W} = 27$). Accordingly, the value of H/t_W for minimum weight for $\frac{t_W}{t_S} = 0.51$ lies

between 44.6 and 55.3, and because the values are established by red lines, not blue lines, some value of t_W/t_S other than 0.51 will give less weight. Inspection of the charts for other values of t_W/t_S reveals that at the given design values of P_1/t_S and $\frac{P_1}{L/\sqrt{c}}$ the blue region lies between $\frac{H}{t_W} = 55.3$ and $\frac{H}{t_W} = 60.7$ on the chart for $\frac{t_W}{t_S} = 0.40$. By interpolation, the panel proportions corresponding to this blue region are found to be $\frac{H}{t_W} \approx 60.5$ ($\frac{b_W}{t_W} \approx 33$) and $\frac{S}{t_S} \approx 27.0$ ($\frac{b_S}{t_S} \approx 38.0$), and for these proportions $\bar{\sigma}_f \approx 31.3 \text{ ksi}$ and $\sigma_{cr} \approx 31.3 \text{ ksi}$, which are the values for

minimum weight. The actual panel dimensions can be calculated from these proportions as

$$t_W = \frac{t_W}{t_S} t_S$$

$$= 0.40(0.064)$$

$$\approx 0.025 \text{ inch}$$

$$H = \frac{H}{t_W} t_W$$

$$= 60.5(0.025)$$

$$= 1.51 \text{ inches}$$

$$S = \frac{S}{t_S} t_S$$

$$= 27.0(0.064)$$

$$= 1.73 \text{ inches}$$

and the section properties can be determined from table 2 as

$$\bar{h} = \frac{\bar{h}}{t_S} t_S$$

$$= 4.90(0.064)$$

$$= 0.314 \text{ inch}$$

$$\rho = \frac{\rho}{t_S} t_S$$

$$= 8.13(0.064)$$

$$= 0.521 \text{ inch}$$

In order to illustrate the use of the direct-reading design charts when more accuracy than that corresponding to interpolation by inspection is desired, a plot has been made (fig. 12) of the values of $\bar{\sigma}_F$, σ_{cr} ,

and H/t_W given by the charts at the design values of P_1/t_S and $\frac{P_1}{L/\sqrt{c}}$.

The proportions which give the highest value of $\bar{\sigma}_F$ can be readily selected from a plot of this kind. (For the example these proportions are so nearly the same as were obtained by inspection that the values will not be repeated; however, the flatness of the curve of $\bar{\sigma}_F$ against S/t_S in figure 12 shows that, for a fairly wide range of proportions for this particular design, the stress that could be carried would be substantially the same as that for minimum weight.)

As a check on the accuracy of interpolation, the magnitude of \bar{t}/t_S for these proportions can be determined from table 2 and multiplied by the values of t_S and $\bar{\sigma}_F$ for the design. This product should be equal to the design value of P_1 . For the example

$$\bar{\sigma}_F = 31.3 \text{ ksi}$$

$$\frac{\bar{t}}{t_S} = 1.500$$

and

$$\begin{aligned} P_1 &= \bar{\sigma}_F \bar{t} \\ &= \bar{\sigma}_F \frac{\bar{t}}{t_S} t_S \\ &= 31.3(1.500)(0.064) \\ &= 3.0 \text{ kips per inch} \end{aligned}$$

which agrees with the design value of P_1 originally assumed.

Langley Aeronautical Laboratory
 National Advisory Committee for Aeronautics
 Langley Field, Va., July 30, 1948

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TABLE 1.— MATERIAL PROPERTIES AND PROPORTIONS OF
 24S-T ALUMINUM-ALLOY PANELS HAVING EXTRUDED
 STRAIGHT-WEB Y-SECTION STIFFENERS

[For details of stiffener proportions and diameter and pitch of rivets, see tables 2 to 6; for panel dimensions, see fig. 1]

Material properties		
	Aluminum alloy	σ_{cy} (ksi)
Sheet	24S-T	44.0
Stiffeners	24S-T	42.3
Proportions		
$\frac{b_W}{t_W} = 0.56 \frac{H}{t_W} - 0.89$		
$\frac{H}{t_W} = 1.79 \frac{b_W}{t_W} + 1.6$		
$\frac{b_S}{t_S} = \frac{2S}{t_S} - \left(0.58 \frac{H}{t_W} + 3.7 \right) \frac{t_W}{t_S}$		
$\frac{S}{t_S} = 0.5 \frac{b_S}{t_S} + \left(0.52 \frac{b_W}{t_W} + 2.3 \right) \frac{t_W}{t_S}$		

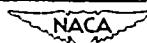


TABLE 2.- Y-PANEL PROPERTIES $\frac{t_H}{t_S} = 0.40$; $\frac{b_A}{t_W} = 9.3$; $\frac{b_Y}{b_H} = 1.04$; $\frac{t_L}{t_W} = 1.06$; $\frac{b_L}{t_W} = 0.94$; $\frac{t_F}{t_W} = 2.13$; $\frac{b_F}{t_W} = 0.69$; $\frac{r}{t_W} = 1$; $\frac{d}{t_S} = 1.5$; $\frac{p}{t_S} = 4.6$

$\frac{b_S}{t_W}$ t_S	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
23	1.496	1.512	1.527	1.542	1.557	1.571	1.585	1.598	1.612	1.624	1.637	1.649	1.661	1.673	1.685	1.696
24	1.481	1.497	1.512	1.526	1.541	1.555	1.568	1.582	1.595	1.608	1.620	1.632	1.644	1.656	1.667	1.678
25	1.467	1.482	1.497	1.512	1.526	1.539	1.553	1.566	1.579	1.591	1.604	1.616	1.628	1.639	1.650	1.662
26	1.454	1.469	1.483	1.497	1.511	1.525	1.538	1.551	1.564	1.576	1.588	1.600	1.612	1.623	1.635	1.646
27	1.441	1.456	1.470	1.484	1.498	1.511	1.524	1.537	1.550	1.563	1.574	1.586	1.597	1.608	1.619	1.630
28	1.429	1.444	1.458	1.472	1.485	1.499	1.511	1.525	1.536	1.548	1.560	1.572	1.583	1.594	1.605	1.616
29	1.416	1.432	1.446	1.460	1.473	1.486	1.499	1.511	1.525	1.535	1.547	1.558	1.569	1.580	1.591	1.602
30	1.407	1.421	1.435	1.448	1.461	1.474	1.486	1.499	1.511	1.523	1.534	1.545	1.557	1.568	1.579	1.589
31	1.397	1.411	1.424	1.437	1.450	1.463	1.475	1.488	1.500	1.510	1.522	1.533	1.544	1.555	1.566	1.576
32	1.388	1.401	1.414	1.427	1.440	1.452	1.464	1.476	1.488	1.499	1.510	1.521	1.532	1.543	1.554	1.564
33	1.378	1.391	1.404	1.417	1.430	1.443	1.454	1.465	1.477	1.488	1.499	1.510	1.521	1.532	1.542	1.552
34	1.370	1.382	1.393	1.405	1.420	1.432	1.444	1.455	1.467	1.478	1.489	1.500	1.511	1.521	1.532	1.551
35	1.361	1.374	1.388	1.401	1.414	1.426	1.438	1.449	1.460	1.472	1.483	1.494	1.505	1.516	1.526	1.536
36	1.357	1.366	1.378	1.390	1.402	1.414	1.425	1.436	1.447	1.458	1.469	1.479	1.489	1.500	1.510	1.520
37	1.346	1.358	1.370	1.382	1.394	1.405	1.416	1.427	1.438	1.449	1.460	1.470	1.481	1.490	1.500	1.510
38	1.338	1.350	1.362	1.374	1.385	1.397	1.400	1.411	1.420	1.430	1.441	1.451	1.461	1.471	1.481	1.490
39	1.331	1.343	1.355	1.366	1.378	1.389	1.392	1.401	1.411	1.421	1.432	1.442	1.452	1.462	1.472	1.482
40	1.324	1.336	1.348	1.359	1.370	1.381	1.392	1.403	1.413	1.424	1.434	1.445	1.455	1.464	1.473	1.482
41	1.312	1.323	1.334	1.345	1.356	1.367	1.378	1.388	1.398	1.408	1.418	1.428	1.437	1.447	1.456	1.465
42	1.300	1.311	1.322	1.333	1.345	1.356	1.367	1.378	1.388	1.398	1.408	1.418	1.428	1.437	1.447	1.456
43	1.289	1.301	1.310	1.321	1.331	1.341	1.351	1.361	1.371	1.380	1.390	1.399	1.408	1.417	1.426	1.435
44	1.279	1.289	1.300	1.310	1.320	1.330	1.340	1.350	1.360	1.370	1.380	1.390	1.400	1.410	1.420	1.430
45	1.270	1.280	1.290	1.300	1.310	1.320	1.330	1.340	1.350	1.360	1.370	1.380	1.390	1.400	1.410	1.420
46	1.261	1.271	1.280	1.290	1.299	1.309	1.318	1.327	1.336	1.345	1.354	1.363	1.371	1.380	1.388	1.396
47	1.252	1.261	1.272	1.281	1.290	1.299	1.308	1.317	1.326	1.335	1.344	1.353	1.362	1.370	1.378	1.386
48	1.245	1.254	1.263	1.272	1.281	1.290	1.299	1.308	1.317	1.326	1.335	1.344	1.353	1.362	1.370	1.378
49	1.237	1.247	1.256	1.265	1.273	1.282	1.291	1.299	1.308	1.317	1.326	1.335	1.344	1.353	1.362	1.370
50	1.231	1.239	1.244	1.253	1.262	1.271	1.280	1.289	1.298	1.307	1.316	1.325	1.334	1.343	1.352	1.360
51	1.221	1.230	1.239	1.247	1.255	1.263	1.271	1.279	1.287	1.295	1.303	1.311	1.318	1.326	1.333	1.341
52	1.212	1.220	1.229	1.237	1.245	1.253	1.261	1.269	1.276	1.284	1.291	1.299	1.306	1.314	1.321	1.328
53	1.208	1.212	1.220	1.228	1.236	1.243	1.251	1.259	1.267	1.274	1.281	1.288	1.295	1.302	1.309	1.316
54	1.196	1.204	1.212	1.220	1.228	1.236	1.243	1.251	1.259	1.267	1.274	1.281	1.288	1.295	1.302	1.309
55	1.189	1.197	1.204	1.212	1.219	1.226	1.234	1.241	1.248	1.255	1.262	1.269	1.276	1.282	1.288	1.294
56	1.182	1.190	1.197	1.204	1.212	1.219	1.226	1.233	1.240	1.246	1.253	1.260	1.266	1.273	1.279	1.284
57	1.177	1.184	1.191	1.198	1.205	1.212	1.218	1.224	1.230	1.236	1.242	1.248	1.254	1.260	1.266	1.271
58	1.171	1.178	1.185	1.192	1.198	1.205	1.212	1.218	1.224	1.230	1.236	1.242	1.248	1.254	1.260	1.266
59	2.788	2.979	3.172	3.369	3.571	3.773	3.979	4.185	4.398	4.607	4.823	5.036	5.256	5.477	5.700	5.922
60	2.741	2.931	3.122	3.314	3.514	3.715	3.916	4.122	4.324	4.521	4.725	4.926	5.139	5.349	5.559	5.763
61	2.697	2.881	3.071	3.264	3.459	3.656	3.856	4.059	4.255	4.450	4.653	4.855	5.057	5.261	5.464	5.666
62	2.655	2.843	3.022	3.210	3.403	3.599	3.797	3.995	4.193	4.389	4.586	4.784	4.982	5.184	5.386	5.588
63	2.612	2.793	2.976	3.162	3.354	3.546	3.741	3.940	4.143	4.345	4.541	4.740	4.941	5.142	5.343	5.544
64	2.573	2.751	2.932	3.115	3.304	3.495	3.685	3.886	4.084	4.284	4.484	4.685	4.885	5.086	5.287	5.488
65	2.534	2.709	2.886	3.072	3.261	3.452	3.643	3.842	4.042	4.242	4.442	4.643	4.844	5.045	5.246	5.447
66	2.496	2.669	2.847	3.026	3.216	3.406	3.596	3.786	3.985	4.184	4.384	4.585	4.785	4.986	5.187	5.388
67	2.453	2.632	2.805	2.984	3.174	3.364	3.554	3.753	3.952	4.151	4.352	4.553	4.754	4.955	5.156	5.357
68	2.429	2.596	2.767	2.943	3.123	3.313	3.503	3.692	3.881	4.080	4.281	4.482	4.683	4.884	5.085	5.286
69	2.392	2.556	2.728	2.902	3.081	3.271	3.461	3.650	3.849	4.038	4.239	4.438	4.639	4.839	5.039	5.239
70	2.344	2.524	2.692	2.865	3.039	3.217	3.408	3.597	3.786	3.975	4.174	4.375	4.576	4.776	4.977	5.178
71	2.320	2.493	2.662	2.832	3.000	3.187	3.377	3.567	3.756	3.945	4.144	4.345	4.546	4.746	4.947	5.148
72	2.300	2.462	2.634	2.790	2.961	3.151	3.341	3.531	3.721	3.910	4.109	4.309	4.509	4.709	4.909	5.109
73	2.274	2.434	2.604	2.765	2.935	3.125	3.315	3.505	3.695	3.884	4.074	4.274	4.474	4.674	4.874	5.074
74	2.247	2.414	2.586	2.756	2.926	3.115	3.305	3.495	3.685	3.874	4.064	4.264	4.464	4.664	4.864	5.064
75	2.216	2.384	2.556	2.726	2.895	3.084	3.274	3.464	3.653	3.842	4.032	4.232	4.432	4.632	4.832	5.032
76	2.184	2.351	2.521	2.691	2.861	3.051	3.241	3.431	3.621	3.810	3.999	4.198	4.397	4.597	4.797	4.997
77	2.154	2.319	2.481	2.649	2.819	3.008	3.198	3.388	3.577	3.766	3.955	4.154	4.354	4.554	4.754	4.954
78	2.121	2.289	2.451	2.619	2.789	2.978	3.168	3.357	3.546	3.735	3.924	4.123	4.323	4.523	4.723	4.923
79	2.090	2.259	2.421	2.589	2.759	2.948	3.138	3.327	3.516	3.705	3.894	4.093	4.293	4.493	4.693	4.893
80	2.057	2.227	2.391	2.551	2.721	2.890	3.079	3.268	3.457	3.646	3.835	4.034	4.234	4.434	4.634	4.834
81	2.025	2.191	2.356	2.516	2.685	2.854	3.043	3.232	3.421	3.610	3.809	4.008	4.207	4.407	4.607	4.807
82	1.989	2.152	2.312	2.471	2.640	2.809	3.000	3.189	3.378	3.567	3.756	3.955	4.154	4.354	4.554	4.754
83	1.953	2.112	2.274	2.434	2.603	2.773	2.963	3.152	3.341	3.530	3.729	3.928	4.127	4.327	4.527	4.727
84	1.922															

TABLE 3.- Y-PANEL PROPERTIES $\frac{t_w}{t_s} = 0.51$; $\frac{b_A}{t_w} = 9.3$; $\frac{b_y}{t_w} = 1.04$; $\frac{t_L}{t_w} = 1.06$; $\frac{b_L}{b_H} = 0.94$; $\frac{t_P}{t_w} = 2.13$; $\frac{b_P}{b_H} = 0.69$; $\frac{r}{t_w} = 1$; $\frac{d}{t_s} = 2.0$; $\frac{p}{t_s} = 6.0$

$\frac{b_H}{t_s}$	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
23	1.749	1.770	1.792	1.812	1.832	1.852	1.871	1.889	1.907	1.924	1.941	1.958	1.974	1.989	2.004	2.019
24	1.728	1.749	1.770	1.790	1.810	1.829	1.848	1.866	1.884	1.901	1.918	1.934	1.950	1.966	1.981	1.996
25	1.708	1.729	1.750	1.770	1.789	1.808	1.827	1.845	1.862	1.880	1.896	1.912	1.928	1.944	1.959	1.974
26	1.689	1.710	1.730	1.750	1.769	1.784	1.807	1.824	1.842	1.859	1.875	1.891	1.907	1.923	1.934	1.952
27	1.671	1.692	1.712	1.731	1.750	1.769	1.787	1.805	1.822	1.839	1.856	1.871	1.887	1.902	1.917	1.932
28	1.654	1.674	1.694	1.714	1.732	1.751	1.769	1.786	1.803	1.820	1.836	1.852	1.868	1.884	1.893	1.907
29	1.636	1.656	1.676	1.697	1.715	1.734	1.751	1.769	1.785	1.802	1.818	1.834	1.850	1.866	1.879	1.893
30	1.623	1.642	1.662	1.681	1.698	1.717	1.734	1.752	1.768	1.785	1.801	1.816	1.832	1.847	1.861	1.875
31	1.608	1.628	1.647	1.665	1.683	1.701	1.718	1.735	1.752	1.768	1.784	1.800	1.816	1.832	1.844	1.858
32	1.594	1.613	1.632	1.650	1.668	1.686	1.703	1.720	1.736	1.752	1.768	1.783	1.798	1.813	1.827	1.841
33	1.581	1.600	1.618	1.636	1.654	1.671	1.688	1.705	1.721	1.737	1.752	1.768	1.783	1.797	1.811	1.826
34	1.568	1.587	1.605	1.623	1.640	1.657	1.674	1.691	1.707	1.722	1.738	1.753	1.767	1.782	1.796	1.810
35	1.556	1.574	1.592	1.610	1.627	1.644	1.661	1.679	1.695	1.708	1.723	1.738	1.753	1.767	1.781	1.795
36	1.544	1.562	1.580	1.598	1.615	1.631	1.648	1.664	1.679	1.695	1.710	1.725	1.739	1.753	1.767	1.781
37	1.533	1.551	1.569	1.586	1.602	1.619	1.635	1.651	1.666	1.682	1.697	1.711	1.726	1.740	1.753	1.767
38	1.522	1.540	1.557	1.574	1.591	1.607	1.623	1.639	1.654	1.669	1.684	1.698	1.713	1.727	1.740	1.754
39	1.512	1.529	1.546	1.563	1.580	1.596	1.611	1.627	1.642	1.657	1.672	1.686	1.700	1.714	1.727	1.741
40	1.502	1.519	1.536	1.553	1.569	1.586	1.600	1.616	1.631	1.646	1.660	1.674	1.688	1.702	1.715	1.728
42	1.483	1.500	1.516	1.533	1.548	1.564	1.579	1.593	1.609	1.623	1.637	1.651	1.664	1.679	1.692	1.705
43	1.466	1.482	1.498	1.514	1.531	1.548	1.565	1.574	1.589	1.603	1.617	1.630	1.644	1.657	1.670	1.683
44	1.450	1.466	1.481	1.497	1.512	1.526	1.541	1.555	1.569	1.583	1.597	1.610	1.623	1.636	1.649	1.662
45	1.435	1.450	1.465	1.480	1.495	1.510	1.524	1.538	1.552	1.566	1.581	1.595	1.608	1.621	1.634	1.647
46	1.420	1.436	1.451	1.465	1.480	1.494	1.508	1.521	1.535	1.549	1.564	1.578	1.591	1.604	1.617	1.630
47	1.407	1.422	1.437	1.450	1.465	1.479	1.492	1.506	1.519	1.532	1.546	1.560	1.573	1.586	1.599	1.606
48	1.394	1.409	1.423	1.437	1.451	1.465	1.478	1.491	1.504	1.517	1.530	1.542	1.554	1.566	1.578	1.590
49	1.383	1.397	1.411	1.425	1.438	1.452	1.465	1.478	1.491	1.504	1.517	1.530	1.542	1.553	1.565	1.574
50	1.372	1.386	1.399	1.413	1.428	1.442	1.454	1.468	1.481	1.494	1.507	1.520	1.533	1.545	1.557	1.559
51	1.362	1.375	1.388	1.402	1.416	1.431	1.444	1.457	1.470	1.483	1.496	1.509	1.521	1.533	1.545	1.545
52	1.354	1.369	1.382	1.395	1.408	1.421	1.434	1.447	1.460	1.473	1.486	1.499	1.511	1.523	1.535	1.535
53	1.344	1.358	1.371	1.384	1.397	1.410	1.423	1.436	1.449	1.462	1.475	1.488	1.500	1.512	1.524	1.527
54	1.331	1.345	1.358	1.371	1.384	1.397	1.410	1.423	1.436	1.449	1.462	1.475	1.488	1.500	1.512	1.515
55	1.321	1.334	1.347	1.360	1.373	1.386	1.399	1.412	1.425	1.438	1.451	1.464	1.477	1.489	1.501	1.504
56	1.310	1.322	1.333	1.346	1.359	1.372	1.385	1.398	1.411	1.424	1.437	1.450	1.463	1.475	1.487	1.490
57	1.299	1.311	1.322	1.333	1.346	1.359	1.372	1.385	1.398	1.411	1.424	1.437	1.450	1.463	1.475	1.487
58	1.289	1.300	1.311	1.322	1.333	1.346	1.359	1.372	1.385	1.398	1.411	1.424	1.437	1.450	1.463	1.475
59	1.280	1.291	1.301	1.312	1.323	1.334	1.346	1.359	1.372	1.385	1.398	1.411	1.424	1.437	1.450	1.463
60	1.271	1.282	1.292	1.302	1.313	1.323	1.334	1.346	1.359	1.372	1.385	1.398	1.411	1.424	1.437	1.450
61	4.209	4.502	4.803	5.103	5.409	5.719	6.021	6.321	6.621	6.921	7.220	7.520	7.820	8.120	8.420	8.720
62	4.189	4.439	4.735	5.035	5.337	5.642	5.952	6.252	6.552	6.852	7.152	7.452	7.752	8.052	8.352	8.652
63	4.091	4.378	4.672	4.968	5.267	5.570	5.878	6.187	6.487	6.787	7.087	7.387	7.687	8.087	8.387	8.687
64	4.034	4.319	4.608	4.902	5.200	5.500	5.806	6.106	6.406	6.706	7.006	7.306	7.606	8.006	8.306	8.606
65	3.978	4.262	4.549	4.858	5.152	5.452	5.753	6.053	6.353	6.653	6.953	7.253	7.553	7.853	8.153	8.453
66	3.925	4.204	4.488	4.779	5.068	5.368	5.665	5.965	6.265	6.565	6.865	7.165	7.465	7.765	8.065	8.365
67	3.874	4.152	4.433	4.719	5.006	5.302	5.596	5.898	6.197	6.497	6.797	7.097	7.397	7.697	8.097	8.397
68	3.825	4.084	4.362	4.643	4.932	5.229	5.529	5.829	6.129	6.429	6.729	7.029	7.329	7.629	8.029	8.329
69	3.775	4.048	4.324	4.602	4.892	5.192	5.492	5.792	6.092	6.392	6.692	6.992	7.292	7.592	7.892	8.192
70	3.724	3.995	4.270	4.546	4.828	5.118	5.418	5.718	6.018	6.318	6.618	6.918	7.218	7.518	7.818	8.118
71	3.663	3.949	4.218	4.493	4.774	5.063	5.363	5.663	5.963	6.263	6.563	6.863	7.163	7.463	7.763	8.063
72	3.612	3.862	4.140	4.416	4.696	5.000	5.296	5.596	5.896	6.196	6.496	6.796	7.096	7.396	7.696	8.096
73	3.559	3.768	4.030	4.295	4.561	4.837	5.114	5.414	5.714	6.014	6.314	6.614	6.914	7.214	7.514	7.814
74	3.471	3.729	4.083	4.348	4.612	4.882	5.152	5.452	5.752	6.052	6.352	6.652	6.952	7.252	7.552	7.852
75	3.433	3.682	3.938	4.200	4.467	4.738	5.006	5.266	5.566	5.866	6.166	6.466	6.766	7.066	7.366	7.666
76	3.395	3.563	3.847	4.117	4.387	4.657	4.927	5.197	5.467	5.737	6.007	6.277	6.547	6.817	7.117	7.417
77	3.341	3.515	3.785	4.052	4.324	4.594	4.864	5.134	5.404	5.674	5.944	6.214	6.484	6.754	7.024	7.324
78	3.290	3.462	3.732	4.002	4.272	4.542	4.812	5.082	5.352	5.622	5.892	6.162	6.432	6.702	7.072	7.372
79	3.244	3.442	3.701	3.969	4.231	4.499	4.769	5.039	5.309	5.579	5.849	6.119	6.389	6.659	7.029	7.329
80	3.202	3.422	3.673	3.942	4.202	4.462	4.732	5.002	5.272	5.542	5.812	6.082	6.352	6.622	7.002	7.302
81	3.159	3.573	3.752	3.942	4.209	4.469	4.738	5.008	5.278	5.548	5.818	6.088	6.358	6.628	7.008	7.308
82	3.147	3.547	3.718	3.886	4.157	4.427	4.697	5.007	5.277	5.547	5.817	6.087	6.357	6.627	7.007	7.307
83	3.095	3.504	3.676	3.845	4.115	4.385	4.655	4.925	5.195	5.465	5.735	6.005	6.275	6.545	6.915	7.315
84	3.044	3.389	3.746	3.109	4.047	4.317	4.587	4.857	5.127	5.397	5.667	6.037	6.307	6.577	7.047	7.447
85	2.981	3.326	3.68													

TABLE 4.- X-PANEL PROPERTIES $\frac{t_w}{t_s} = 0.63$; $\frac{b_1}{t_w} = 9.3$; $\frac{b_2}{t_w} = 1.04$; $\frac{t_L}{t_w} = 1.06$; $\frac{b_L}{t_w} = 0.94$; $\frac{t_F}{t_w} = 2.13$; $\frac{b_F}{t_w} = 0.69$; $\frac{r}{t_w} = 1$; $\frac{d}{t_s} = 1.8$; $\frac{P}{t_s} = 6.1$

$\frac{b_1}{t_w}$	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
23	2.059	2.080	2.115	2.142	2.167	2.192	2.216	2.240	2.263	2.285	2.306	2.327	2.347	2.366	2.385	2.404
24	2.031	2.059	2.087	2.113	2.139	2.164	2.188	2.211	2.234	2.255	2.277	2.297	2.318	2.337	2.357	2.375
25	2.005	2.033	2.060	2.086	2.112	2.136	2.160	2.184	2.206	2.228	2.249	2.270	2.290	2.309	2.328	2.347
26	1.980	2.008	2.035	2.061	2.086	2.110	2.134	2.157	2.180	2.201	2.222	2.243	2.263	2.282	2.301	2.320
27	1.955	1.984	2.010	2.036	2.061	2.085	2.109	2.132	2.154	2.176	2.197	2.217	2.238	2.257	2.276	2.294
28	1.934	1.961	1.987	2.013	2.034	2.062	2.085	2.103	2.120	2.151	2.172	2.193	2.213	2.232	2.251	2.269
29	1.912	1.939	1.965	1.990	2.015	2.039	2.068	2.085	2.107	2.128	2.149	2.169	2.189	2.208	2.227	2.245
30	1.892	1.918	1.945	1.969	1.993	2.017	2.040	2.062	2.085	2.106	2.126	2.146	2.166	2.185	2.205	2.222
31	1.872	1.898	1.924	1.948	1.973	1.996	2.019	2.041	2.063	2.084	2.104	2.125	2.144	2.163	2.182	2.200
32	1.853	1.879	1.904	1.929	1.953	1.976	1.999	2.021	2.042	2.063	2.084	2.104	2.125	2.142	2.161	2.179
33	1.835	1.861	1.886	1.910	1.935	1.957	1.979	2.001	2.022	2.043	2.064	2.083	2.103	2.122	2.140	2.158
34	1.817	1.847	1.872	1.896	1.915	1.938	1.960	1.982	2.003	2.024	2.044	2.064	2.082	2.102	2.120	2.138
35	1.801	1.826	1.851	1.874	1.898	1.920	1.942	1.964	1.986	2.005	2.025	2.045	2.064	2.083	2.101	2.120
36	1.782	1.810	1.834	1.858	1.881	1.903	1.925	1.946	1.966	1.986	2.006	2.027	2.046	2.064	2.083	2.100
37	1.770	1.794	1.818	1.842	1.864	1.887	1.908	1.929	1.950	1.970	1.990	2.009	2.028	2.047	2.065	2.082
38	1.752	1.779	1.803	1.826	1.849	1.871	1.892	1.913	1.934	1.954	1.973	1.993	2.011	2.030	2.048	2.067
39	1.741	1.765	1.788	1.811	1.834	1.855	1.877	1.897	1.918	1.938	1.957	1.976	1.995	2.013	2.031	2.049
40	1.727	1.751	1.774	1.799	1.819	1.840	1.861	1.882	1.902	1.924	1.944	1.963	1.982	2.001	2.019	2.037
42	1.707	1.725	1.747	1.769	1.791	1.812	1.833	1.853	1.873	1.892	1.911	1.930	1.948	1.966	1.983	2.001
44	1.678	1.700	1.722	1.744	1.765	1.786	1.806	1.824	1.845	1.865	1.883	1.902	1.919	1.937	1.954	1.971
46	1.655	1.677	1.699	1.720	1.741	1.761	1.781	1.801	1.820	1.838	1.857	1.875	1.892	1.910	1.927	1.944
48	1.634	1.656	1.677	1.698	1.718	1.738	1.757	1.777	1.795	1.814	1.832	1.850	1.867	1.884	1.901	1.917
50	1.618	1.635	1.656	1.677	1.696	1.716	1.735	1.754	1.772	1.791	1.808	1.826	1.843	1.860	1.876	1.893
52	1.598	1.616	1.637	1.657	1.676	1.695	1.714	1.733	1.751	1.769	1.786	1.803	1.820	1.837	1.853	1.869
54	1.578	1.599	1.619	1.638	1.657	1.676	1.695	1.713	1.731	1.748	1.765	1.783	1.799	1.815	1.831	1.847
56	1.562	1.582	1.603	1.620	1.639	1.657	1.676	1.694	1.711	1.728	1.745	1.762	1.778	1.794	1.810	1.826
58	1.546	1.566	1.585	1.604	1.622	1.640	1.658	1.676	1.693	1.710	1.726	1.743	1.759	1.775	1.790	1.806
60	1.532	1.551	1.570	1.589	1.608	1.626	1.641	1.659	1.678	1.692	1.708	1.725	1.740	1.756	1.772	1.787
63	1.511	1.530	1.548	1.567	1.586	1.601	1.618	1.634	1.651	1.667	1.683	1.699	1.714	1.730	1.745	1.759
65	1.492	1.510	1.528	1.545	1.562	1.579	1.597	1.612	1.628	1.644	1.659	1.675	1.690	1.705	1.720	1.734
67	1.475	1.491	1.509	1.526	1.543	1.559	1.575	1.591	1.607	1.622	1.637	1.653	1.667	1.682	1.696	1.711
72	1.442	1.460	1.475	1.491	1.507	1.523	1.538	1.553	1.568	1.584	1.599	1.614	1.626	1.640	1.654	1.668
75	1.425	1.444	1.460	1.476	1.491	1.506	1.521	1.536	1.550	1.565	1.579	1.594	1.609	1.621	1.635	1.648
78	1.405	1.420	1.440	1.451	1.467	1.482	1.491	1.506	1.520	1.535	1.549	1.564	1.578	1.593	1.606	1.620
81	1.387	1.402	1.417	1.432	1.447	1.462	1.476	1.491	1.505	1.519	1.533	1.546	1.560	1.573	1.586	1.612
83	5.943	6.339	6.775	7.202	7.627	8.057	8.469	8.927	9.366	9.806	10.25	10.69	11.14	11.58	12.03	12.49
84	5.872	6.284	6.702	7.122	7.547	7.975	8.405	8.837	9.274	9.710	10.15	10.59	11.04	11.48	11.94	12.38
85	5.805	6.214	6.628	7.045	7.468	7.891	8.319	8.752	9.184	9.621	10.06	10.50	10.94	11.38	11.83	12.28
86	5.738	6.185	6.557	6.972	7.390	7.811	8.237	8.665	9.098	9.529	9.965	10.41	10.85	11.28	11.73	12.18
87	5.672	6.027	6.484	6.897	7.313	7.732	8.156	8.582	9.010	9.413	9.877	10.31	10.75	11.19	11.64	12.08
88	5.611	6.011	6.415	6.826	7.240	7.657	8.076	8.503	8.927	9.355	9.787	10.22	10.66	11.10	11.54	11.98
89	5.560	5.936	6.348	6.754	7.166	7.581	7.999	8.340	8.761	9.190	9.615	10.05	10.49	10.91	11.35	11.79
90	5.489	5.862	6.283	6.687	7.094	7.507	7.922	8.340	8.761	9.180	9.605	10.05	10.49	10.91	11.35	11.79
91	5.430	5.768	6.219	6.618	7.026	7.444	7.864	8.284	8.704	9.125	9.541	9.962	10.39	10.82	11.26	11.70
92	5.372	5.761	6.158	6.554	6.965	7.364	7.776	8.194	8.606	9.027	9.432	9.856	10.31	10.74	11.17	11.61
93	5.316	5.703	6.094	6.489	6.891	7.296	7.702	8.115	8.529	8.948	9.365	9.782	10.25	10.65	11.08	11.51
94	5.265	5.644	6.033	6.427	6.823	7.226	7.631	8.042	8.454	8.872	9.290	9.714	10.14	10.57	10.99	11.43
95	5.207	5.687	5.975	6.363	6.762	7.159	7.562	7.972	8.382	8.794	9.211	9.633	10.06	10.48	10.91	11.36
96	5.151	5.513	5.815	6.216	6.624	7.034	7.446	7.856	8.266	8.676	9.095	9.515	9.935	10.35	10.74	11.25
97	5.104	5.428	5.808	6.157	6.567	7.042	7.454	7.864	8.274	8.684	9.103	9.521	9.935	10.35	10.74	11.25
98	5.053	5.374	5.784	6.147	6.557	7.027	7.436	7.846	8.256	8.666	9.085	9.508	9.914	10.36	10.74	11.25
99	5.004	5.374	5.745	6.126	6.536	7.026	7.436	7.856	8.266	8.676	9.095	9.516	9.926	10.36	10.74	11.25
100	4.952	5.253	5.696	6.076	6.486	7.026	7.436	7.856	8.266	8.676	9.095	9.516	9.926	10.36	10.74	11.25
101	4.862	5.226	5.692	5.947	6.247	6.727	7.116	7.507	7.904	8.302	8.704	9.112	9.521	9.935	10.35	10.74
102	4.776	5.174	5.504	5.744	6.044	6.524	6.918	7.335	7.733	8.143	8.545	8.957	9.377	9.787	10.20	10.61
103	4.688	5.040	5.399	5.633	6.031	6.470	6.876	7.286	7.686	8.084	8.484	8.841	9.239	9.647	10.06	10.47
104	4.608	4.955	5.307	5.668	6.051	6.401	6.813	7.223	7.623	8.022	8.422	8.821	9.221	9.621	10.02	10.42
105	4.526	4.867	5.217	5.575	5.931	6.298	6.688	7.094	7.494	7.894	8.294	8.695	9.095	9.497	9.895	10.36
106	4.452	4.787	5.134	5.484	5.838	6.248	6.658	7.068	7.478	7.877	8.277	8.677	9.074	9.477	9.876	10.34
107	4.376	4.713	5.053	5.396	5.747	6.105	6.470	6.836	7.208	7.583	8.343	8.732	9.121	9.514	9.912	10.34
108	4.308	4.677	4.970	5.311	5.659	6.010	6.372	6.736	7.101	7.471	7.848	8.229	8.611	8.997	9.388	9.784
109	4.237															

TABLE 5.- Y-PANEL PROPERTIES $\frac{t_w}{t_s} = 0.79$; $\frac{b_y}{t_w} = 9.3$; $\frac{b_y}{t_w} = 1.04$; $\frac{t_t}{t_w} = 1.06$; $\frac{b_L}{t_w} = 0.94$; $\frac{t_b}{t_w} = 2.13$; $\frac{b_F}{t_w} = 0.69$; $\frac{r}{t_w} = 1$; $\frac{d}{t_s} = 2.3$; $\frac{p}{t_s} = 7.7$

$\frac{b_y}{t_w}$	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
23	2.517	2.551	2.590	2.624	2.657	2.689	2.720	2.749	2.778	2.806	2.832	2.853	2.883	2.907	2.931	2.955
24	2.451	2.518	2.552	2.588	2.621	2.652	2.683	2.713	2.741	2.769	2.796	2.822	2.847	2.871	2.892	2.917
25	2.446	2.483	2.519	2.552	2.585	2.617	2.648	2.677	2.706	2.734	2.761	2.787	2.812	2.836	2.860	2.883
26	2.441	2.480	2.492	2.512	2.531	2.551	2.581	2.611	2.641	2.670	2.697	2.733	2.778	2.803	2.826	2.849
27	2.302	2.318	2.422	2.457	2.487	2.520	2.551	2.582	2.611	2.640	2.668	2.694	2.720	2.746	2.770	2.795
28	2.352	2.383	2.423	2.456	2.489	2.520	2.551	2.580	2.609	2.636	2.663	2.689	2.714	2.739	2.763	2.786
29	2.343	2.359	2.394	2.427	2.459	2.490	2.521	2.550	2.579	2.606	2.633	2.659	2.684	2.709	2.733	2.756
30	2.296	2.331	2.366	2.399	2.421	2.456	2.487	2.521	2.550	2.577	2.601	2.630	2.655	2.680	2.704	2.727
31	2.269	2.304	2.339	2.373	2.403	2.434	2.464	2.494	2.522	2.550	2.576	2.602	2.627	2.651	2.678	2.698
32	2.211	2.279	2.313	2.345	2.377	2.408	2.438	2.467	2.495	2.522	2.549	2.575	2.600	2.621	2.648	2.671
33	2.219	2.254	2.288	2.320	2.352	2.382	2.412	2.441	2.469	2.496	2.523	2.548	2.573	2.598	2.623	2.645
34	2.196	2.230	2.261	2.296	2.327	2.358	2.387	2.415	2.443	2.471	2.497	2.523	2.548	2.572	2.596	2.619
35	2.173	2.207	2.241	2.272	2.301	2.331	2.363	2.392	2.420	2.447	2.473	2.500	2.523	2.549	2.574	2.599
36	2.152	2.185	2.218	2.250	2.281	2.311	2.340	2.368	2.396	2.423	2.450	2.477	2.504	2.531	2.557	2.580
37	2.151	2.161	2.197	2.228	2.259	2.289	2.318	2.346	2.373	2.400	2.426	2.452	2.479	2.500	2.524	2.547
38	2.110	2.141	2.175	2.208	2.238	2.267	2.296	2.321	2.351	2.378	2.404	2.429	2.452	2.478	2.503	2.524
39	2.091	2.121	2.156	2.187	2.213	2.243	2.271	2.300	2.327	2.357	2.382	2.408	2.432	2.459	2.479	2.502
40	2.072	2.105	2.136	2.167	2.197	2.225	2.255	2.283	2.310	2.336	2.362	2.387	2.411	2.435	2.461	2.481
42	2.036	2.068	2.100	2.130	2.159	2.188	2.216	2.244	2.270	2.296	2.322	2.346	2.371	2.394	2.417	2.440
44	2.003	2.035	2.065	2.092	2.124	2.154	2.180	2.207	2.235	2.259	2.284	2.308	2.332	2.356	2.379	2.401
46	1.971	2.000	2.032	2.064	2.090	2.118	2.145	2.172	2.198	2.223	2.248	2.275	2.299	2.319	2.342	2.364
48	1.942	1.972	2.002	2.031	2.059	2.088	2.113	2.139	2.165	2.190	2.215	2.239	2.262	2.285	2.303	2.329
50	1.914	1.942	1.972	2.001	2.029	2.063	2.083	2.106	2.134	2.159	2.183	2.206	2.230	2.252	2.275	2.296
52	1.883	1.917	1.956	1.974	2.001	2.028	2.054	2.079	2.104	2.129	2.153	2.176	2.199	2.221	2.243	2.265
54	1.864	1.892	1.920	1.948	1.974	2.001	2.026	2.051	2.076	2.100	2.124	2.147	2.170	2.192	2.211	2.235
56	1.840	1.868	1.896	1.923	1.949	1.975	2.000	2.025	2.049	2.073	2.096	2.119	2.142	2.164	2.186	2.208
58	1.818	1.846	1.873	1.899	1.925	1.951	1.975	2.000	2.024	2.047	2.070	2.093	2.111	2.137	2.159	2.179
60	1.797	1.821	1.851	1.877	1.902	1.927	1.952	1.975	2.000	2.023	2.047	2.070	2.093	2.111	2.132	2.152
62	1.767	1.794	1.820	1.845	1.870	1.895	1.919	1.944	1.965	1.988	2.010	2.032	2.052	2.075	2.095	2.116
64	1.740	1.765	1.791	1.816	1.840	1.864	1.888	1.911	1.935	1.956	1.977	1.999	2.020	2.041	2.061	2.081
66	1.715	1.740	1.764	1.789	1.812	1.836	1.861	1.881	1.902	1.925	1.948	1.968	1.988	2.009	2.029	2.048
68	1.691	1.712	1.739	1.763	1.786	1.809	1.832	1.854	1.875	1.897	1.918	1.938	1.959	1.979	2.001	2.017
70	1.668	1.692	1.716	1.739	1.762	1.784	1.806	1.828	1.850	1.872	1.894	1.914	1.933	1.950	1.968	1.988
72	1.645	1.671	1.694	1.718	1.741	1.764	1.786	1.807	1.829	1.851	1.873	1.894	1.913	1.931	1.949	1.967
74	1.628	1.651	1.673	1.695	1.717	1.738	1.760	1.781	1.802	1.824	1.845	1.866	1.885	1.903	1.921	1.939
76	1.609	1.632	1.654	1.675	1.697	1.718	1.740	1.761	1.782	1.803	1.824	1.845	1.864	1.882	1.900	1.918
78	1.587	1.608	1.630	1.651	1.672	1.693	1.714	1.735	1.756	1.777	1.798	1.818	1.837	1.855	1.873	1.891
80	1.569	1.591	1.613	1.634	1.655	1.676	1.697	1.718	1.739	1.760	1.781	1.801	1.820	1.838	1.856	1.874
82	1.551	1.572	1.594	1.615	1.636	1.657	1.678	1.699	1.720	1.741	1.762	1.783	1.802	1.820	1.838	1.856
84	1.534	1.555	1.576	1.597	1.618	1.639	1.660	1.681	1.702	1.723	1.744	1.765	1.784	1.802	1.820	1.838
86	1.516	1.537	1.558	1.579	1.599	1.620	1.641	1.662	1.683	1.704	1.725	1.746	1.765	1.784	1.802	1.820
88	1.498	1.519	1.540	1.561	1.582	1.603	1.624	1.645	1.666	1.687	1.708	1.729	1.748	1.767	1.785	1.803
90	1.480	1.499	1.520	1.541	1.562	1.583	1.604	1.625	1.646	1.667	1.688	1.709	1.728	1.747	1.766	1.784
92	1.462	1.481	1.502	1.523	1.544	1.565	1.586	1.607	1.628	1.649	1.670	1.691	1.710	1.729	1.748	1.766
94	1.444	1.463	1.484	1.505	1.526	1.547	1.568	1.589	1.610	1.631	1.652	1.673	1.692	1.711	1.730	1.748
96	1.426	1.445	1.466	1.487	1.508	1.529	1.550	1.571	1.592	1.613	1.634	1.655	1.674	1.693	1.712	1.731
98	1.408	1.427	1.448	1.469	1.490	1.511	1.532	1.553	1.574	1.595	1.616	1.635	1.654	1.673	1.692	1.711
100	1.390	1.409	1.430	1.451	1.472	1.493	1.514	1.535	1.556	1.577	1.598	1.617	1.636	1.655	1.674	1.693
102	1.372	1.391	1.412	1.433	1.454	1.475	1.496	1.517	1.538	1.559	1.579	1.598	1.617	1.636	1.655	1.674
104	1.354	1.373	1.394	1.415	1.436	1.457	1.478	1.499	1.520	1.541	1.562	1.581	1.600	1.619	1.638	1.657
106	1.336	1.355	1.376	1.397	1.418	1.439	1.460	1.481	1.502	1.523	1.544	1.563	1.582	1.601	1.620	1.639
108	1.318	1.337	1.358	1.379	1.399	1.420	1.441	1.462	1.483	1.504	1.525	1.544	1.563	1.582	1.601	1.620
110	1.299	1.318	1.339	1.359	1.379	1.400	1.421	1.442	1.463	1.484	1.505	1.524	1.543	1.562	1.581	1.600
112	1.281	1.299	1.319	1.339	1.359	1.380	1.401	1.422	1.443	1.464	1.485	1.504	1.523	1.542	1.561	1.580
114	1.263	1.281	1.299	1.319	1.339	1.360	1.381	1.402	1.423	1.444	1.465	1.484	1.503	1.522	1.541	1.560
116	1.245	1.263	1.281	1.299	1.319	1.340	1.361	1.382	1.403	1.424	1.445	1.464	1.483	1.502	1.521	1.540
118	1.227	1.245	1.263	1.281	1.299	1.320	1.341	1.362	1.383	1.404	1.425	1.444	1.463	1.482	1.501	1.520
120	1.209	1.227	1.245	1.263	1.281	1.300	1.321	1.342	1.363	1.384	1.405	1.424	1.443	1.462	1.481	1.500
122	1.191	1.209	1.227	1.245	1.263	1.281	1.302	1.323	1.344	1.365	1.386	1.405	1.424	1.443	1.462	1.481
124	1.173	1.191	1.209	1.227	1.245	1.263	1.281	1.302	1.323	1.344	1.365	1.386	1.405	1.424	1.443	1.462
126	1.155	1.173	1.191	1.209	1.227	1.245	1.263	1.281	1.302	1.323	1.344	1.365	1.386	1.405	1.424	1.443
128	1.137	1.155	1.173	1.191	1.209	1.227	1.245	1.263	1.281	1.302	1.323	1.344	1.365	1.386	1.405	1.424
130	1.119	1.137	1.155	1.173	1.191	1.209	1.227	1.245	1.263							

TABLE 6.- Y-PANEL PROPERTIES
 $\frac{t_w}{t_s} = 1.00$; $\frac{b_A}{t_w} = 9.3$; $\frac{b_Y}{t_w} = 1.04$; $\frac{t_L}{t_w} = 1.06$; $\frac{b_L}{t_w} = 0.94$; $\frac{t_P}{t_w} = 2.13$; $\frac{b_P}{t_w} = 0.69$; $\frac{t}{t_w} = 1$; $\frac{d}{t_s} = 2.4$; $\frac{P}{t_s} = 7.8$

$\frac{b}{t_w}$	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
23	3.177	3.225	3.270	3.313	3.355	3.395	3.433	3.470	3.505	3.539	3.572	3.604	3.634	3.663	3.692	3.719
24	3.131	3.178	3.223	3.267	3.309	3.349	3.387	3.424	3.460	3.494	3.527	3.559	3.590	3.619	3.648	3.676
25	3.086	3.133	3.179	3.222	3.264	3.304	3.343	3.380	3.416	3.450	3.483	3.516	3.547	3.576	3.605	3.633
26	3.043	3.090	3.136	3.179	3.221	3.261	3.300	3.338	3.373	3.408	3.441	3.474	3.505	3.535	3.564	3.592
27	3.008	3.049	3.095	3.136	3.180	3.220	3.253	3.296	3.333	3.367	3.401	3.435	3.465	3.495	3.524	3.553
28	2.963	3.010	3.055	3.098	3.140	3.181	3.219	3.257	3.293	3.328	3.362	3.398	3.426	3.455	3.486	3.514
29	2.925	2.972	3.017	3.060	3.102	3.142	3.181	3.219	3.255	3.290	3.324	3.356	3.388	3.412	3.448	3.477
30	2.888	2.932	2.970	3.023	3.065	3.105	3.144	3.182	3.218	3.253	3.287	3.320	3.351	3.382	3.412	3.441
31	2.853	2.900	2.944	2.988	3.028	3.070	3.108	3.146	3.182	3.217	3.251	3.284	3.316	3.349	3.376	3.405
32	2.819	2.865	2.910	2.953	2.992	3.035	3.074	3.111	3.148	3.183	3.217	3.249	3.281	3.312	3.342	3.371
33	2.786	2.833	2.877	2.920	2.962	3.002	3.040	3.078	3.114	3.149	3.183	3.216	3.248	3.279	3.309	3.338
34	2.755	2.801	2.842	2.888	2.929	2.969	3.008	3.045	3.081	3.117	3.150	3.183	3.215	3.246	3.276	3.306
35	2.725	2.770	2.811	2.857	2.898	2.937	2.974	3.014	3.050	3.086	3.119	3.152	3.184	3.215	3.246	3.274
36	2.695	2.741	2.785	2.827	2.868	2.908	2.946	2.983	3.019	3.057	3.088	3.121	3.153	3.184	3.214	3.244
37	2.667	2.712	2.756	2.798	2.839	2.878	2.917	2.954	2.990	3.025	3.058	3.091	3.123	3.154	3.184	3.214
38	2.639	2.684	2.728	2.770	2.810	2.850	2.888	2.925	2.961	2.996	3.030	3.062	3.094	3.125	3.155	3.185
39	2.613	2.657	2.701	2.742	2.783	2.822	2.860	2.897	2.933	2.968	3.001	3.034	3.066	3.097	3.127	3.156
40	2.587	2.631	2.674	2.716	2.755	2.795	2.833	2.870	2.906	2.940	2.974	3.007	3.039	3.070	3.100	3.129
41	2.558	2.582	2.624	2.665	2.705	2.744	2.782	2.818	2.854	2.888	2.921	2.954	2.986	3.017	3.047	3.076
42	2.527	2.552	2.597	2.638	2.677	2.716	2.753	2.789	2.824	2.858	2.891	2.924	2.956	2.986	3.026	3.056
43	2.492	2.515	2.557	2.618	2.657	2.695	2.733	2.769	2.804	2.838	2.872	2.904	2.936	2.966	2.996	3.026
44	2.462	2.485	2.523	2.572	2.612	2.650	2.685	2.722	2.757	2.791	2.824	2.857	2.888	2.919	2.948	2.977
45	2.432	2.451	2.490	2.530	2.569	2.606	2.643	2.678	2.713	2.747	2.779	2.811	2.843	2.873	2.903	2.932
46	2.408	2.446	2.480	2.519	2.559	2.598	2.635	2.671	2.704	2.737	2.768	2.799	2.830	2.869	2.898	2.928
47	2.379	2.403	2.442	2.481	2.519	2.557	2.594	2.631	2.667	2.701	2.734	2.767	2.800	2.831	2.861	2.891
48	2.352	2.373	2.413	2.451	2.489	2.526	2.562	2.596	2.630	2.667	2.700	2.732	2.763	2.794	2.824	2.854
49	2.327	2.348	2.377	2.415	2.452	2.489	2.524	2.558	2.592	2.625	2.658	2.691	2.724	2.754	2.784	2.814
50	2.304	2.334	2.360	2.398	2.437	2.474	2.503	2.536	2.571	2.604	2.637	2.670	2.703	2.734	2.764	2.794
51	2.275	2.295	2.327	2.364	2.398	2.435	2.471	2.508	2.541	2.574	2.606	2.638	2.671	2.702	2.732	2.762
52	2.244	2.264	2.293	2.323	2.352	2.387	2.424	2.458	2.492	2.525	2.558	2.590	2.621	2.652	2.682	2.712
53	2.212	2.232	2.261	2.290	2.319	2.348	2.384	2.419	2.454	2.488	2.520	2.552	2.584	2.615	2.646	2.676
54	2.182	2.202	2.231	2.260	2.289	2.318	2.353	2.388	2.423	2.457	2.489	2.521	2.553	2.584	2.614	2.644
55	2.151	2.179	2.206	2.237	2.265	2.294	2.329	2.364	2.400	2.434	2.467	2.500	2.531	2.561	2.591	2.621
56	2.122	2.150	2.179	2.209	2.238	2.267	2.302	2.337	2.372	2.406	2.438	2.471	2.503	2.534	2.564	2.594
57	2.091	2.121	2.150	2.179	2.208	2.237	2.272	2.307	2.342	2.376	2.408	2.440	2.472	2.504	2.534	2.564
58	2.061	2.091	2.120	2.149	2.178	2.207	2.242	2.277	2.312	2.346	2.378	2.410	2.442	2.474	2.504	2.534
59	2.031	2.061	2.090	2.119	2.148	2.177	2.212	2.247	2.282	2.316	2.348	2.380	2.412	2.444	2.474	2.504
60	2.001	2.031	2.060	2.089	2.118	2.147	2.182	2.217	2.252	2.286	2.318	2.350	2.382	2.414	2.444	2.474
61	1.971	2.001	2.030	2.059	2.088	2.117	2.152	2.187	2.222	2.257	2.289	2.321	2.353	2.385	2.416	2.446
62	1.941	1.971	2.000	2.029	2.058	2.087	2.122	2.157	2.192	2.227	2.259	2.291	2.323	2.355	2.386	2.416
63	1.911	1.941	1.970	2.000	2.029	2.058	2.093	2.128	2.163	2.198	2.230	2.262	2.294	2.326	2.356	2.386
64	1.881	1.911	1.940	1.969	1.998	2.027	2.062	2.097	2.132	2.167	2.200	2.232	2.264	2.296	2.326	2.356
65	1.851	1.881	1.910	1.939	1.968	1.997	2.032	2.067	2.102	2.137	2.170	2.202	2.234	2.266	2.296	2.326
66	1.821	1.851	1.880	1.909	1.938	1.967	2.002	2.037	2.072	2.107	2.140	2.172	2.204	2.236	2.266	2.296
67	1.791	1.821	1.850	1.879	1.908	1.937	1.972	2.007	2.042	2.077	2.110	2.142	2.174	2.206	2.236	2.266
68	1.761	1.791	1.820	1.849	1.878	1.907	1.942	1.977	2.012	2.047	2.080	2.112	2.144	2.176	2.206	2.236
69	1.731	1.761	1.790	1.819	1.848	1.877	1.912	1.947	1.982	2.017	2.050	2.082	2.114	2.146	2.176	2.206
70	1.701	1.731	1.760	1.789	1.818	1.847	1.882	1.917	1.952	1.987	2.020	2.052	2.084	2.116	2.146	2.176
71	1.671	1.701	1.730	1.759	1.788	1.817	1.852	1.887	1.922	1.957	1.990	2.022	2.054	2.086	2.116	2.146
72	1.641	1.671	1.700	1.729	1.758	1.787	1.822	1.857	1.892	1.927	1.960	1.992	2.024	2.056	2.086	2.116
73	1.611	1.641	1.670	1.699	1.728	1.757	1.792	1.827	1.862	1.897	1.930	1.962	1.994	2.026	2.056	2.086
74	1.581	1.611	1.640	1.669	1.698	1.727	1.762	1.797	1.832	1.867	1.900	1.932	1.964	1.996	2.026	2.056
75	1.551	1.581	1.610	1.639	1.668	1.697	1.732	1.767	1.802	1.837	1.870	1.902	1.934	1.966	2.026	2.056
76	1.521	1.551	1.580	1.609	1.638	1.667	1.702	1.737	1.772	1.807	1.840	1.872	1.904	1.936	2.026	2.056
77	1.491	1.521	1.550	1.579	1.608	1.637	1.672	1.707	1.742	1.777	1.810	1.842	1.874	1.906	2.026	2.056
78	1.461	1.491	1.520	1.549	1.578	1.607	1.642	1.677	1.712	1.747	1.780	1.812	1.844	1.876	2.026	2.056
79	1.431	1.461	1.490	1.519	1.548	1.577	1.612	1.647	1.682	1.717	1.750	1.782	1.814	1.846	2.026	2.056
80	1.401	1.431	1.460	1.489	1.518	1.547	1.582	1.617	1.652	1.687	1.720	1.752	1.784	1.816	2.026	2.056
81	1.371	1.401	1.430	1.459	1.488	1.517	1.552	1.587	1.622	1.657	1.690	1.722	1.754	1.786	2.026	2.056
82	1.341	1.371	1.400	1.429	1.458	1.487	1.522	1.557	1.592	1.627	1.660	1.692	1.724	1.756	2.026	2.056
83	1.311	1.341	1.370	1.399	1.428	1.457	1.492	1.527	1.562	1.597	1.630	1.662	1.694	1.726	2.026	2.056
84	1.281	1.311	1.340	1.369	1.398	1.427	1.462	1.497	1.532	1.567	1.600	1.632	1.664	1.696	2.026	2.056
85	1.251	1.281	1.310	1.339	1.368	1.397	1.432	1.467	1.502	1.537						

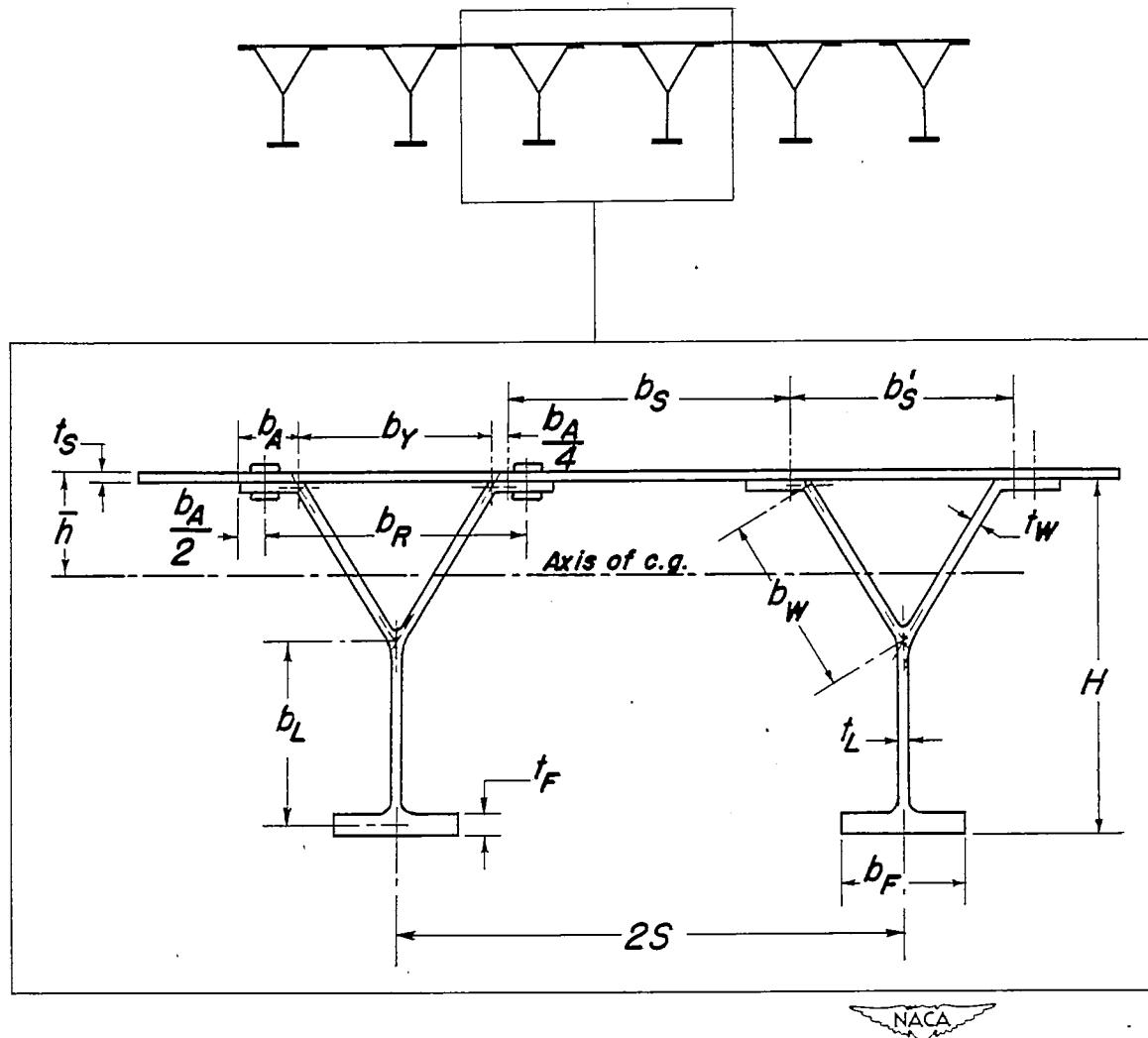


Figure 1.—Symbols for panel dimensions.

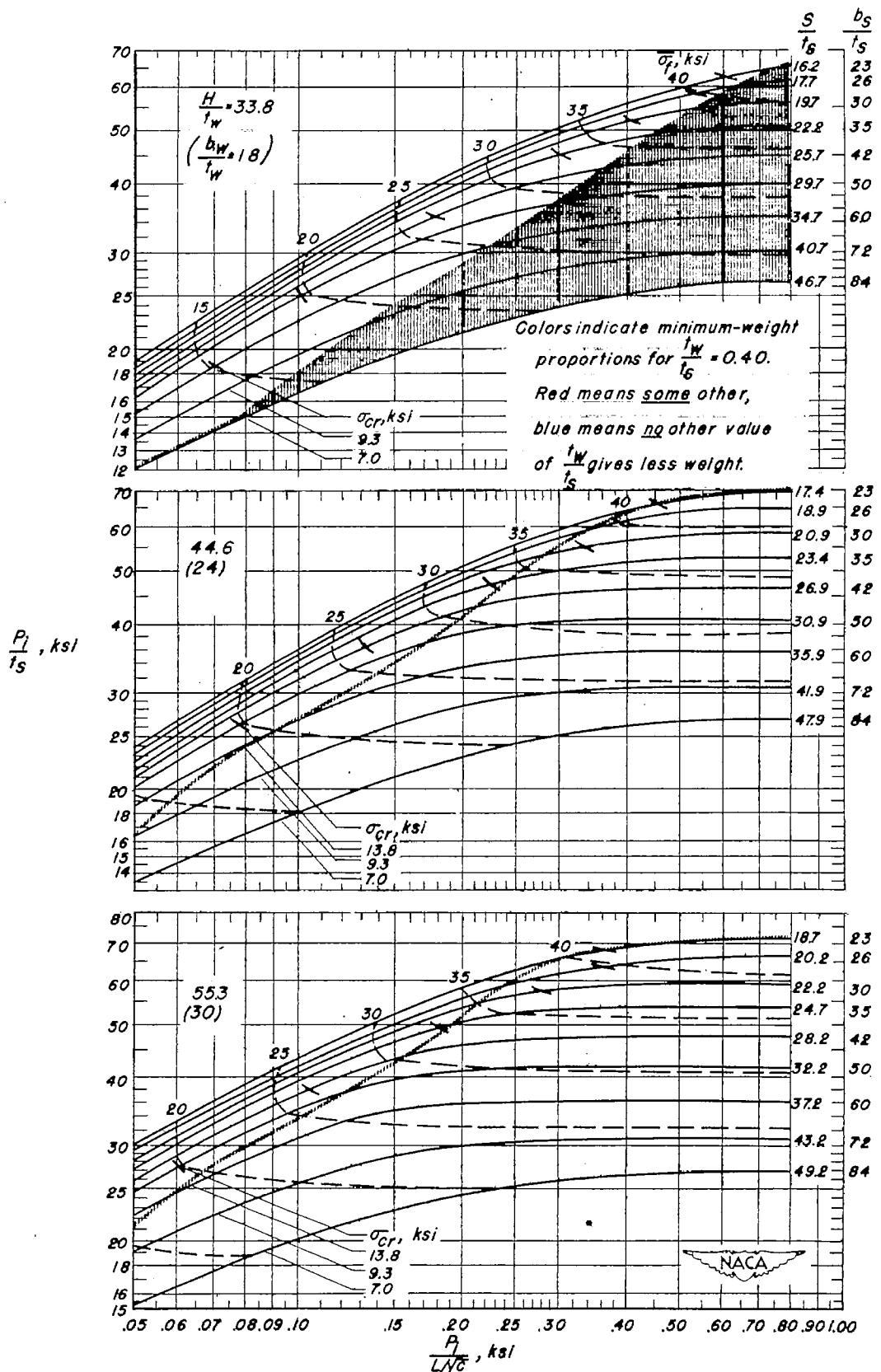
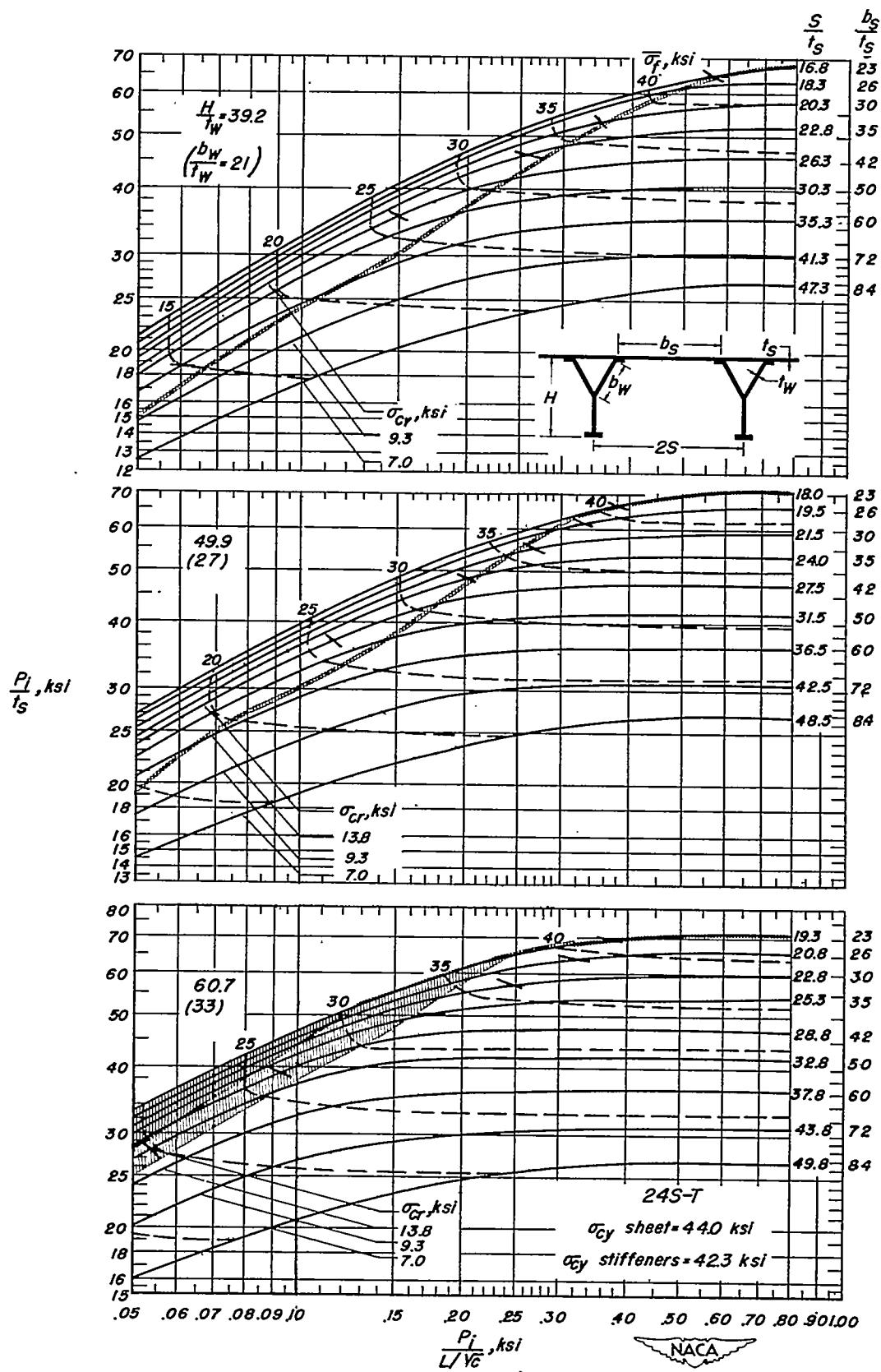


Figure 2.—Direct-reading design chart for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners. $\frac{t_w}{t_s} = 0.40$.

Figure 2—Concluded. $\frac{t_w}{t_s} = 0.40$.

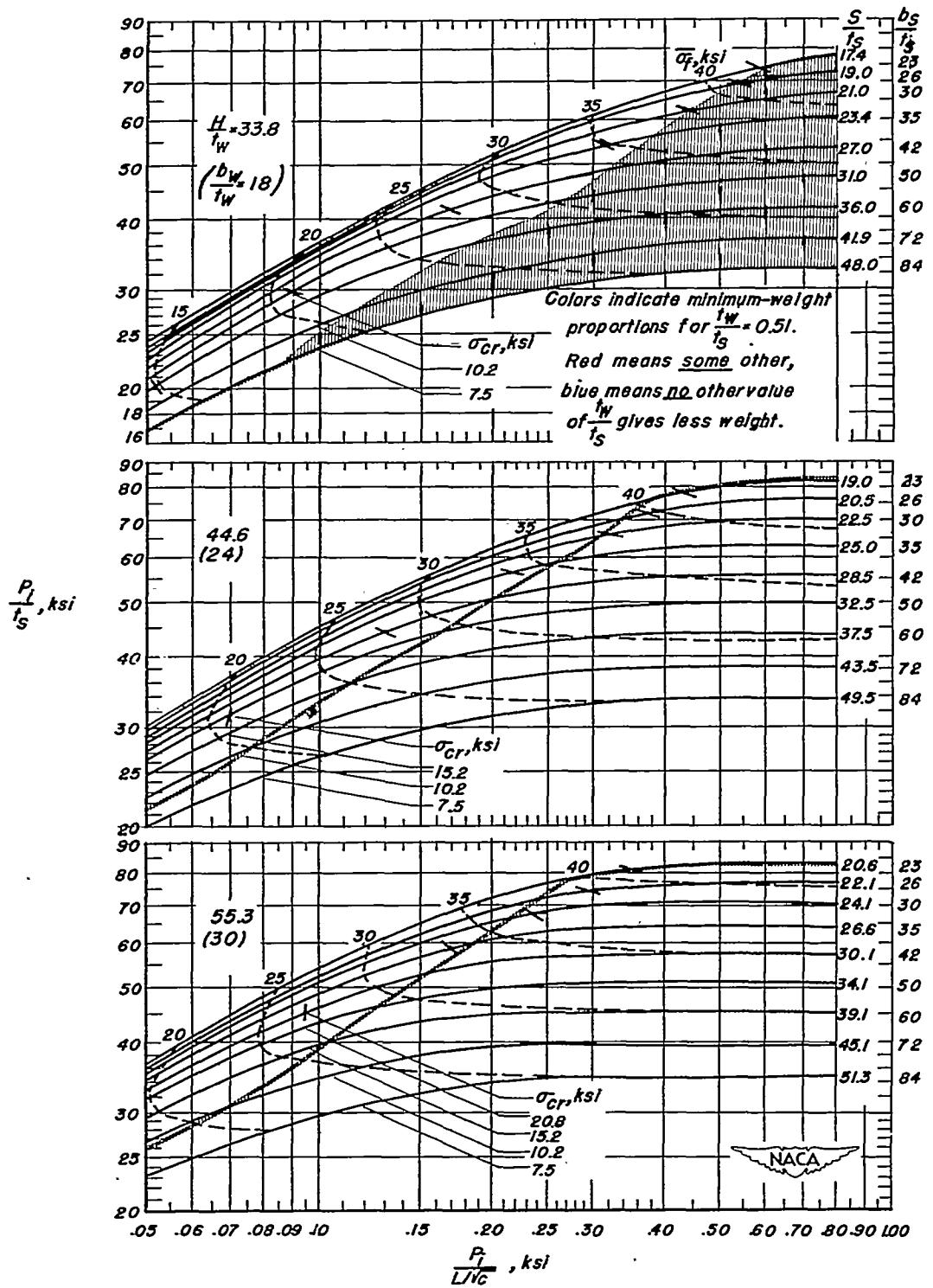
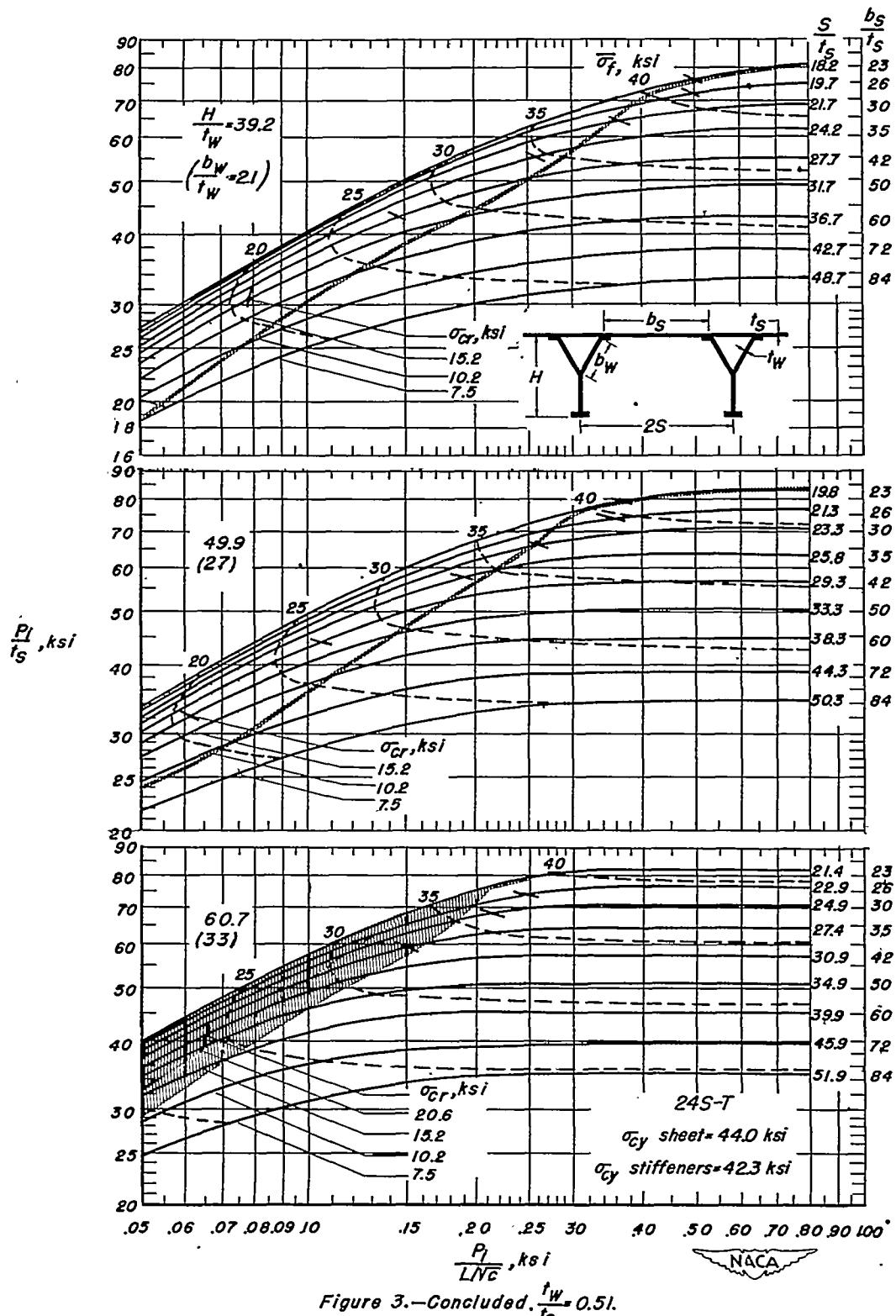


Figure 3.—Direct-reading design chart for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners $\frac{t_w}{t_s} = 0.51$.

Figure 3.—Concluded. $\frac{t_W}{t_S} = 0.51$.

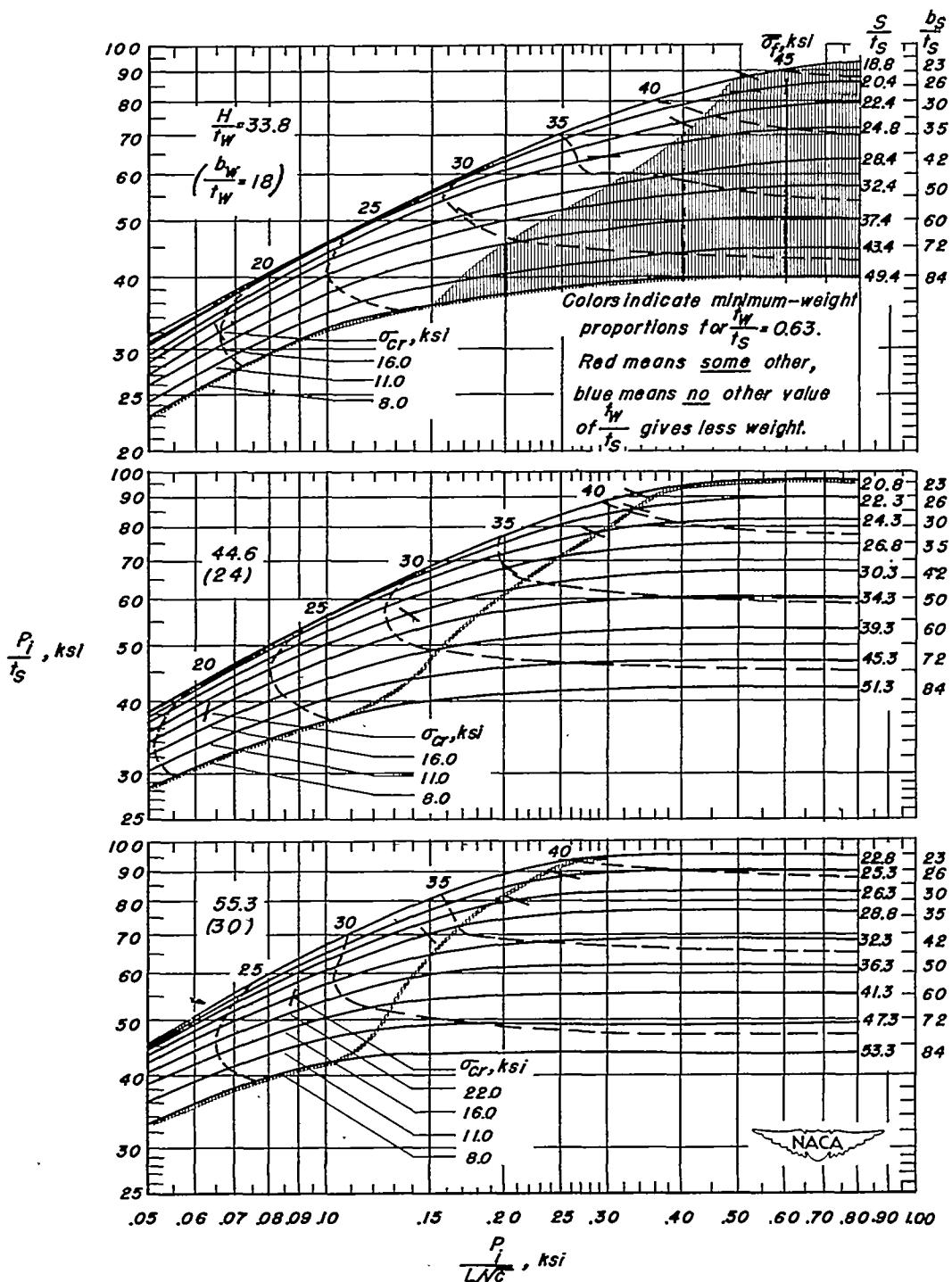


Figure 4.—Direct-reading design chart for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners $\frac{t_w}{t_s} = 0.63$.

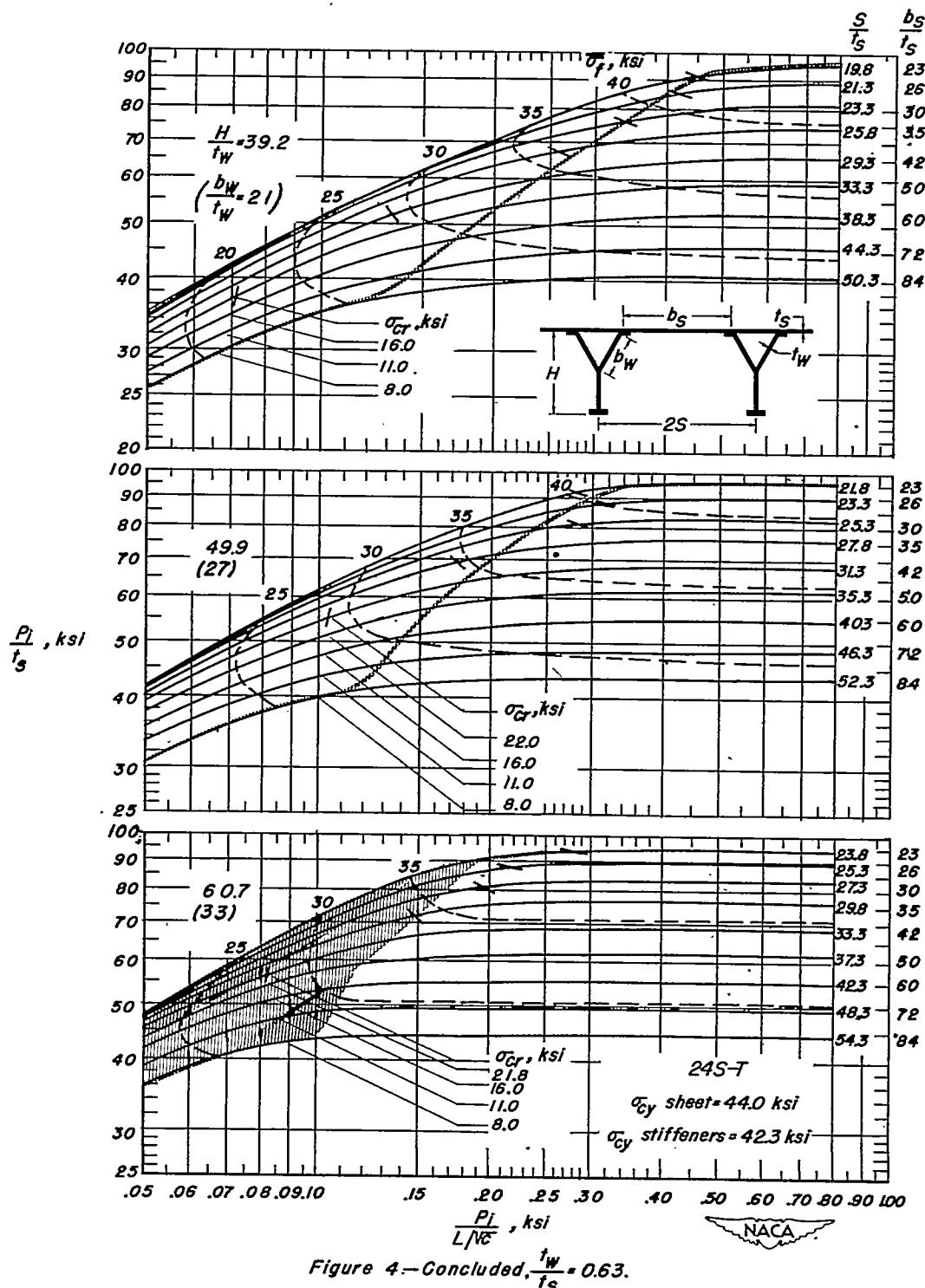


Figure 4.—Concluded, $t_w/t_s = 0.63$.

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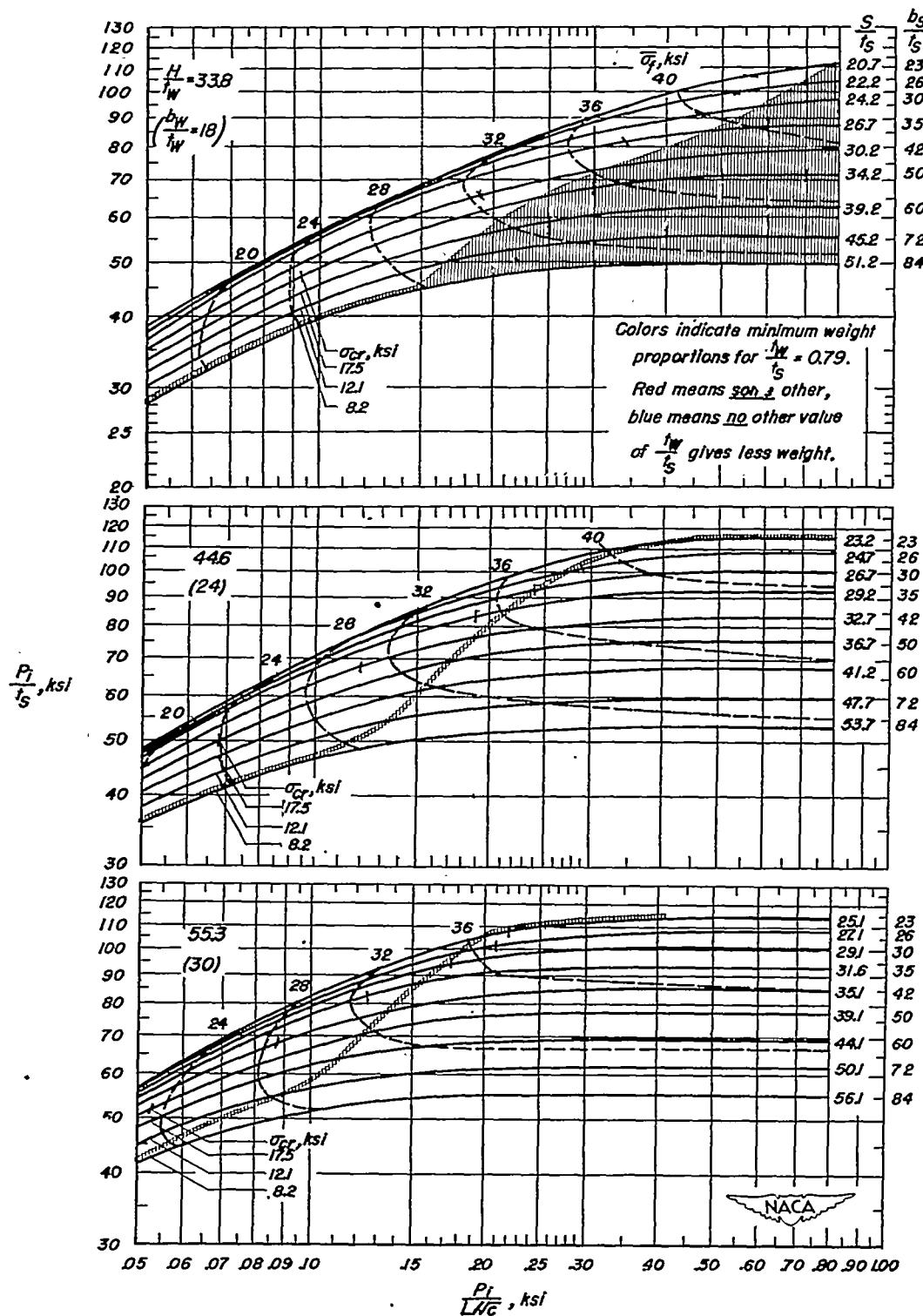
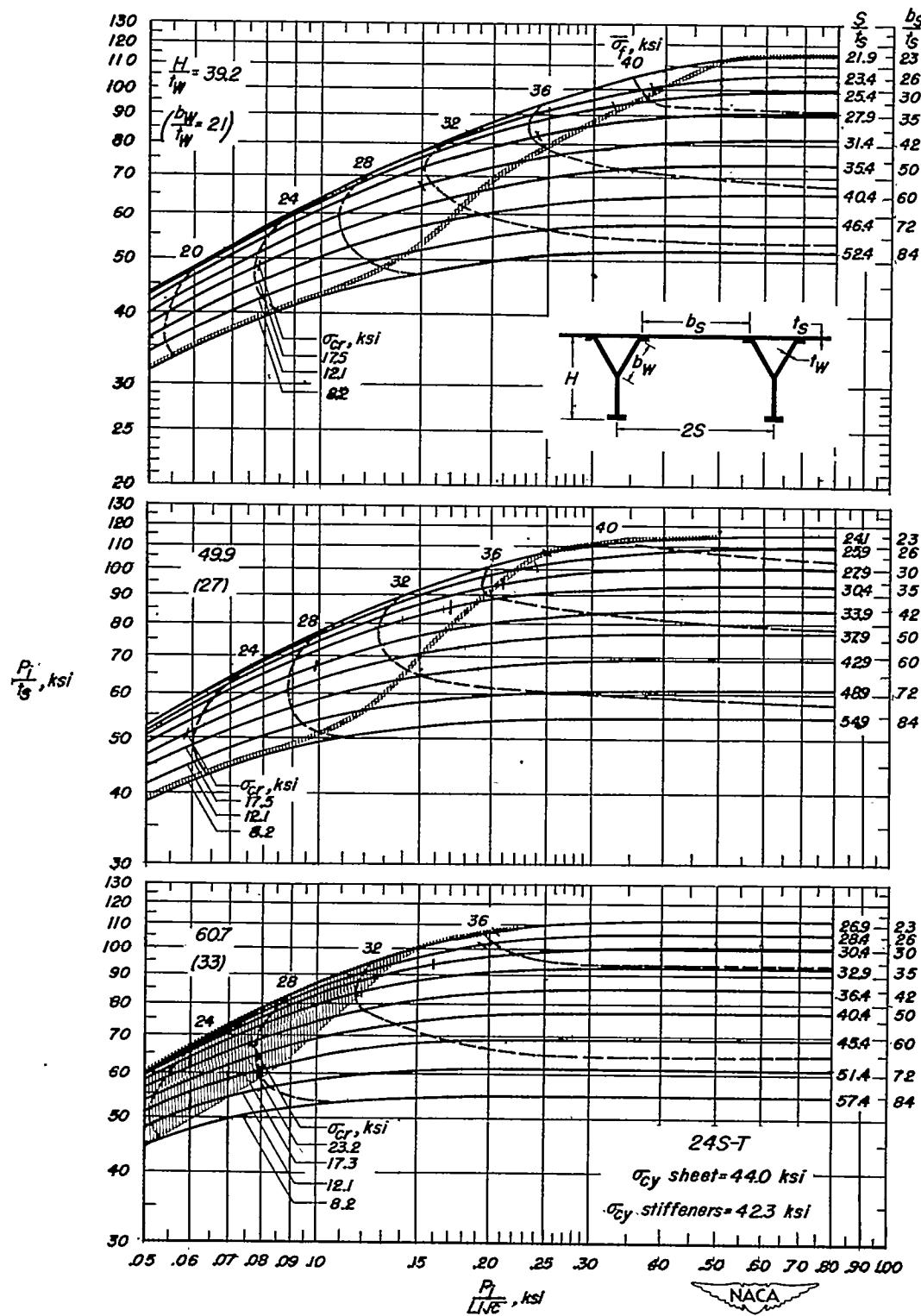


Figure 5.— Direct-reading design chart for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners. $\frac{t_w}{t_s} = 0.79$.

Figure 5-Concluded. $\frac{t_w}{t_s} = 0.79$.

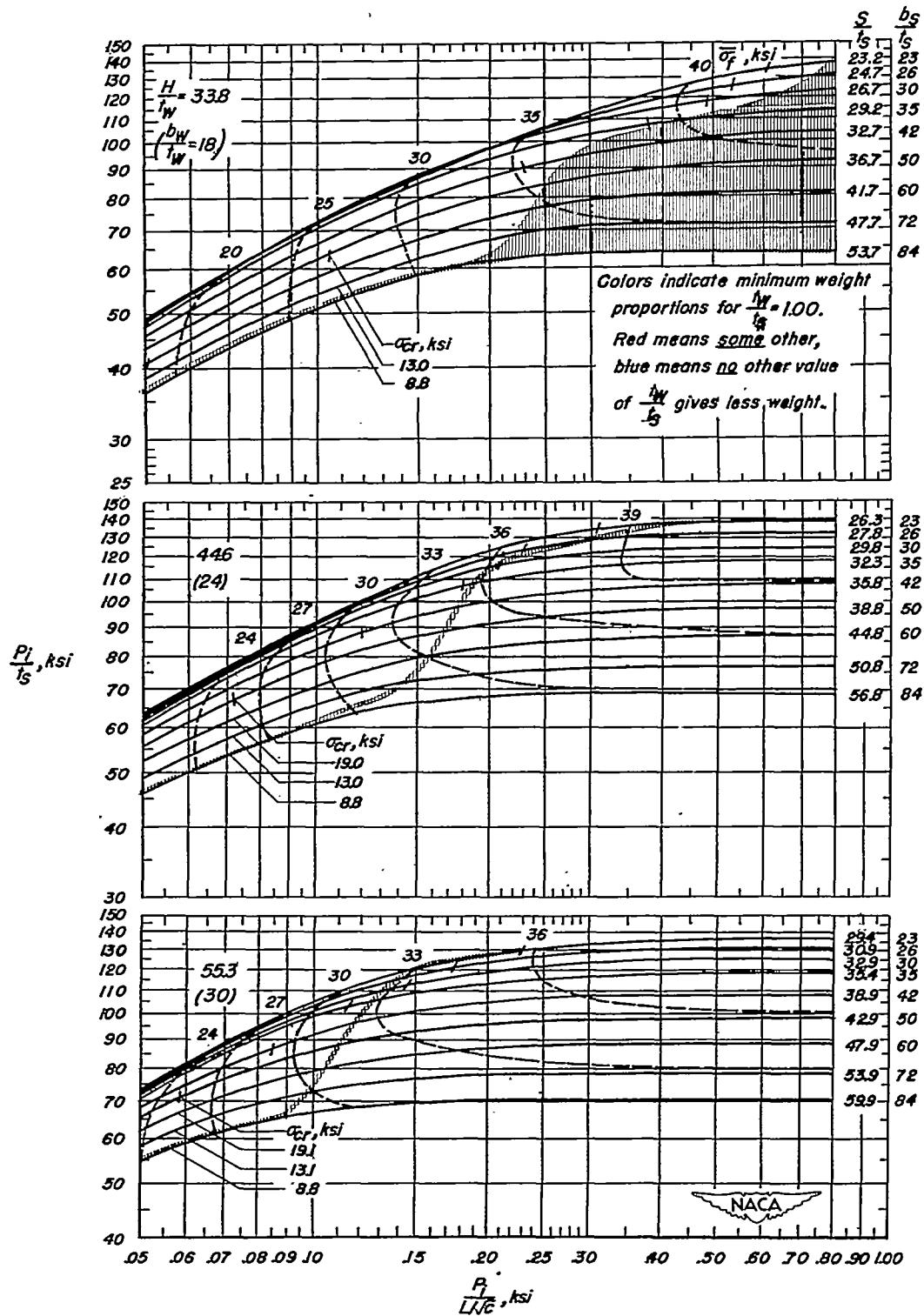
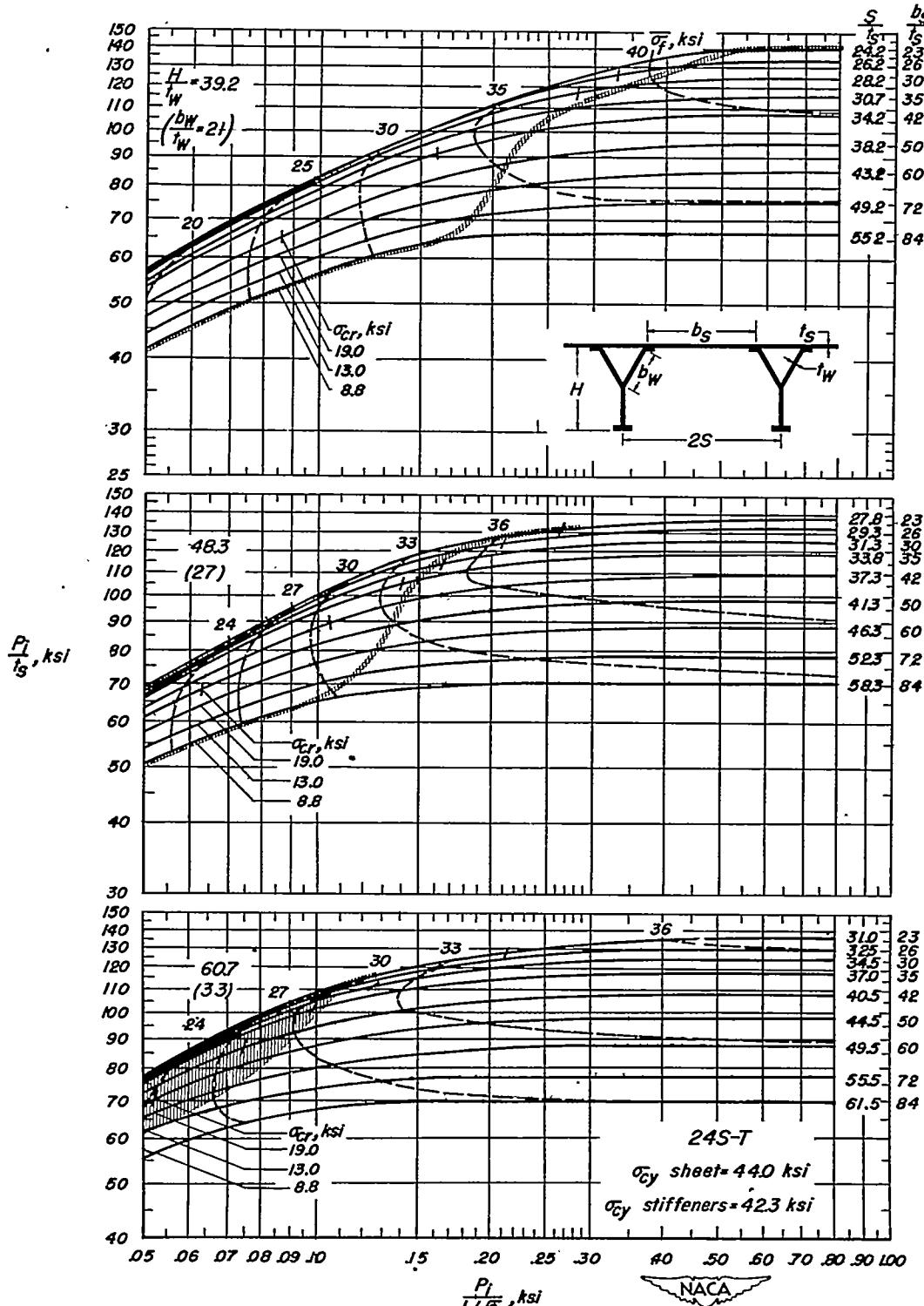


Figure 6.—Direct-reading design chart for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners. $\frac{H}{t_w} = 1.00$.

Figure 6.-Concluded. $\frac{t_w}{t_s} = 100$.

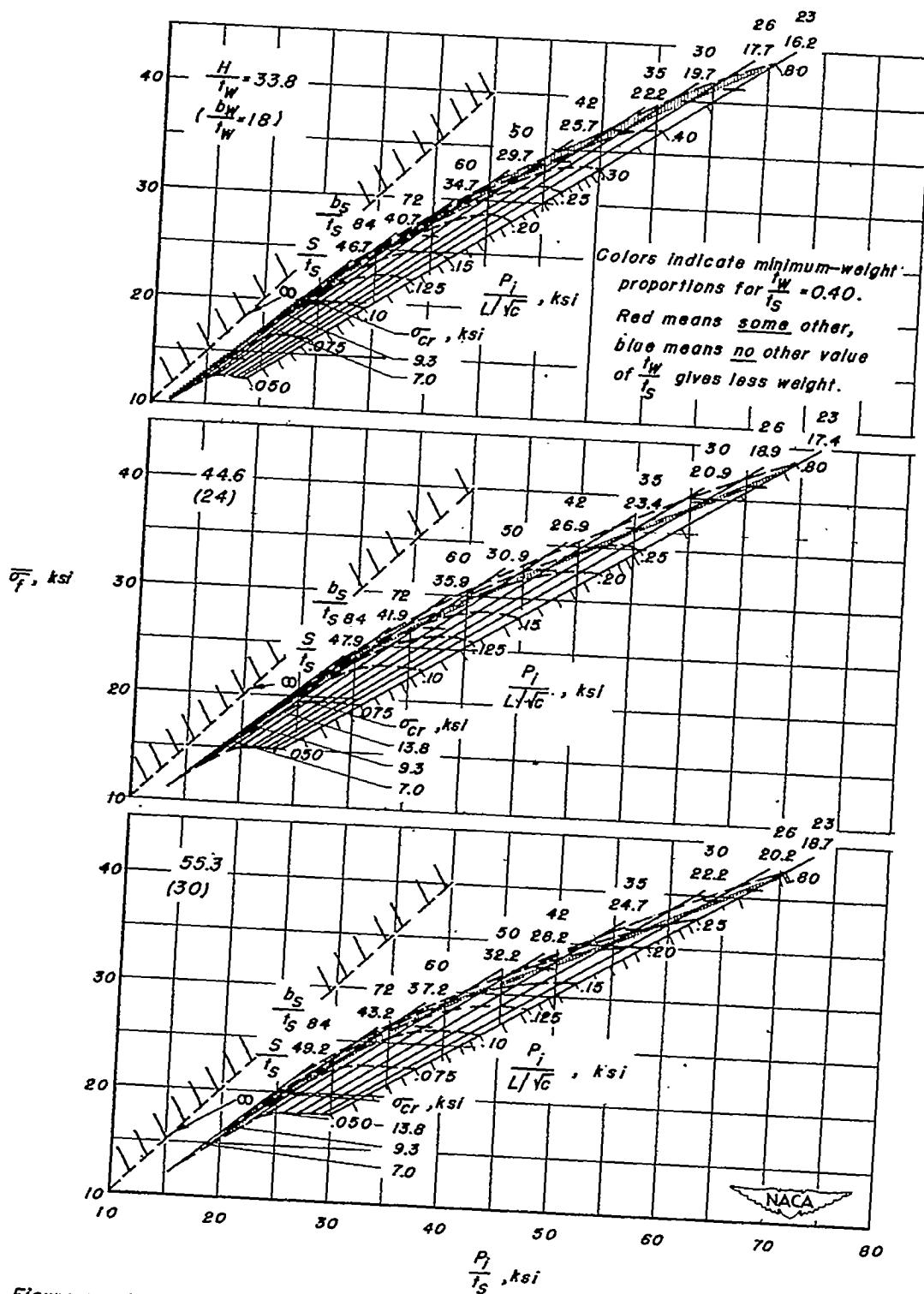
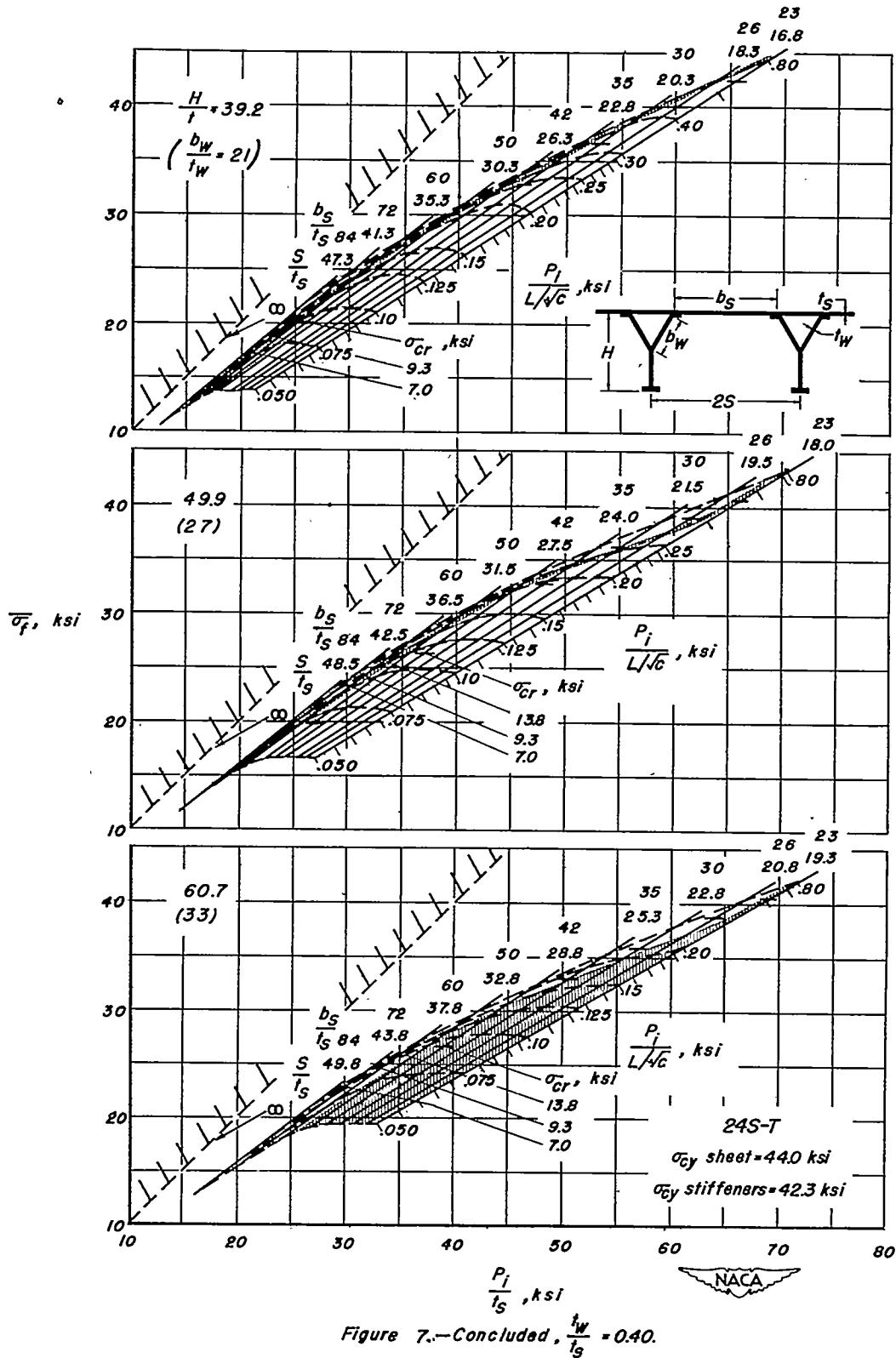


Figure 7.—Direct-reading design chart (alternate form) for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners, $\frac{t_w}{t_s} = 0.40$.

Figure 7.—Concluded, $\frac{t_w}{t_s} = 0.40$.

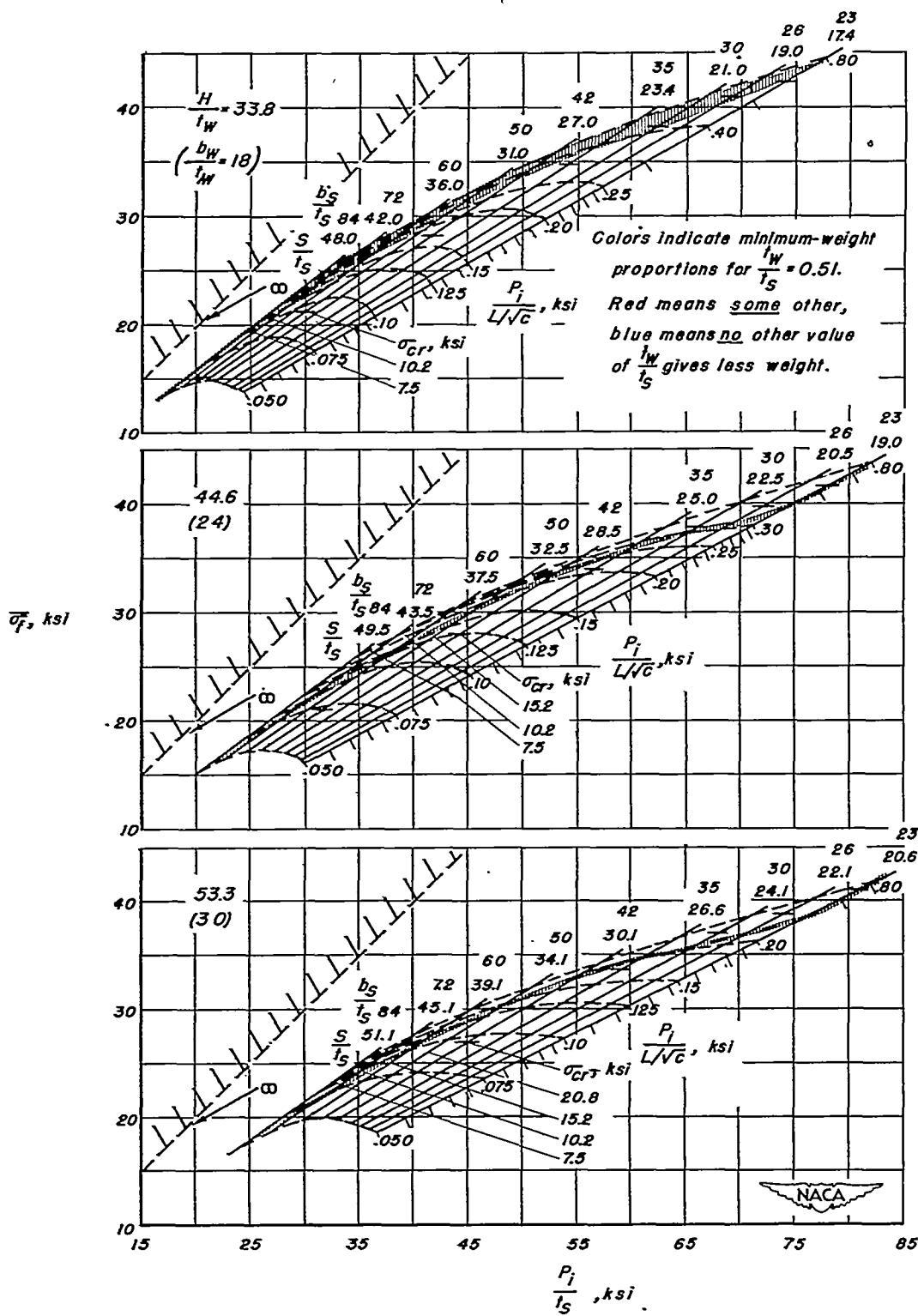
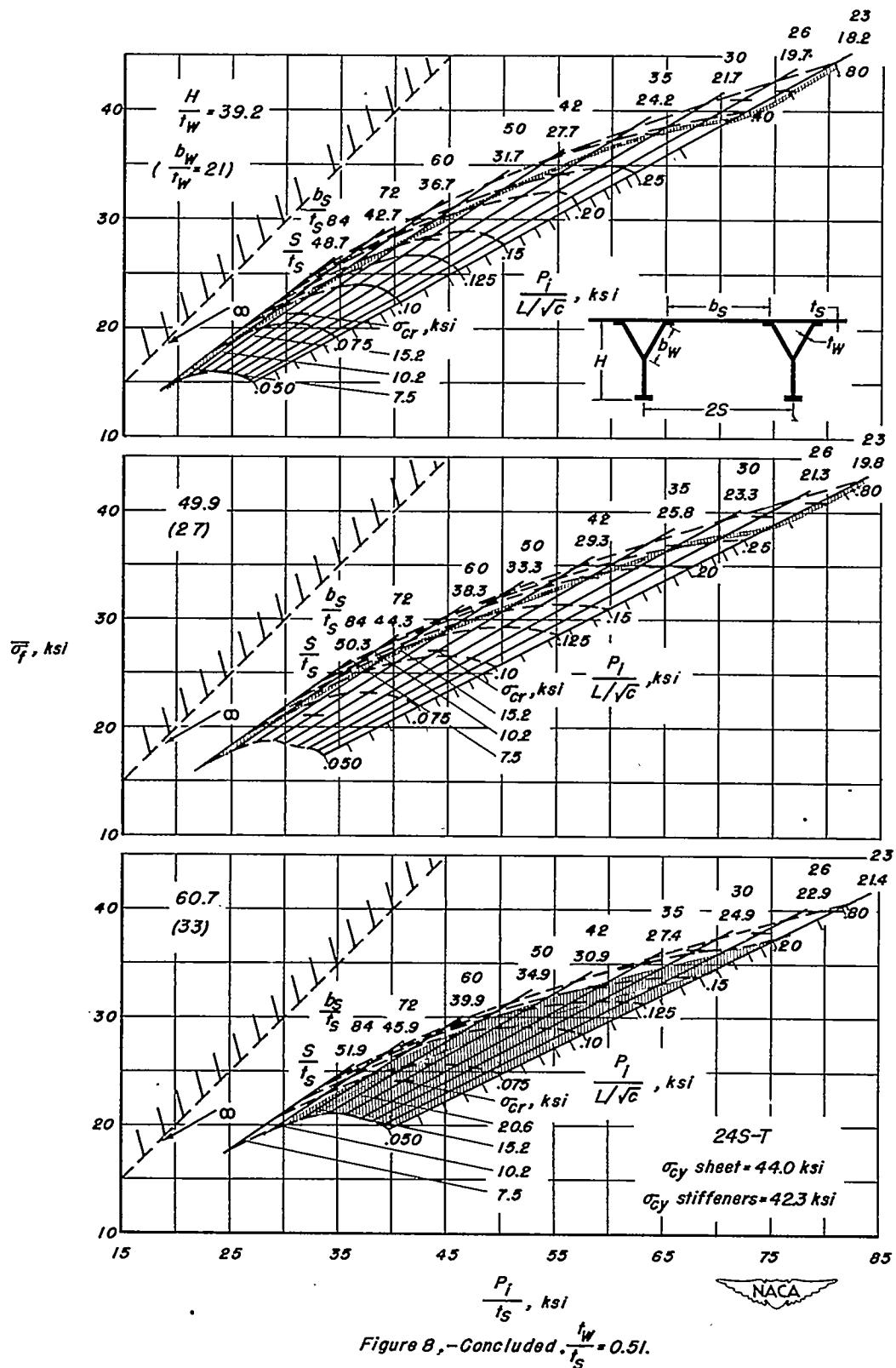


Figure 8.—Direct-reading design chart (alternate form) for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners, $\frac{t_w}{t_s} = 0.51$.

Figure 8,-Concluded. $\frac{t_w}{t_s} = 0.51$.

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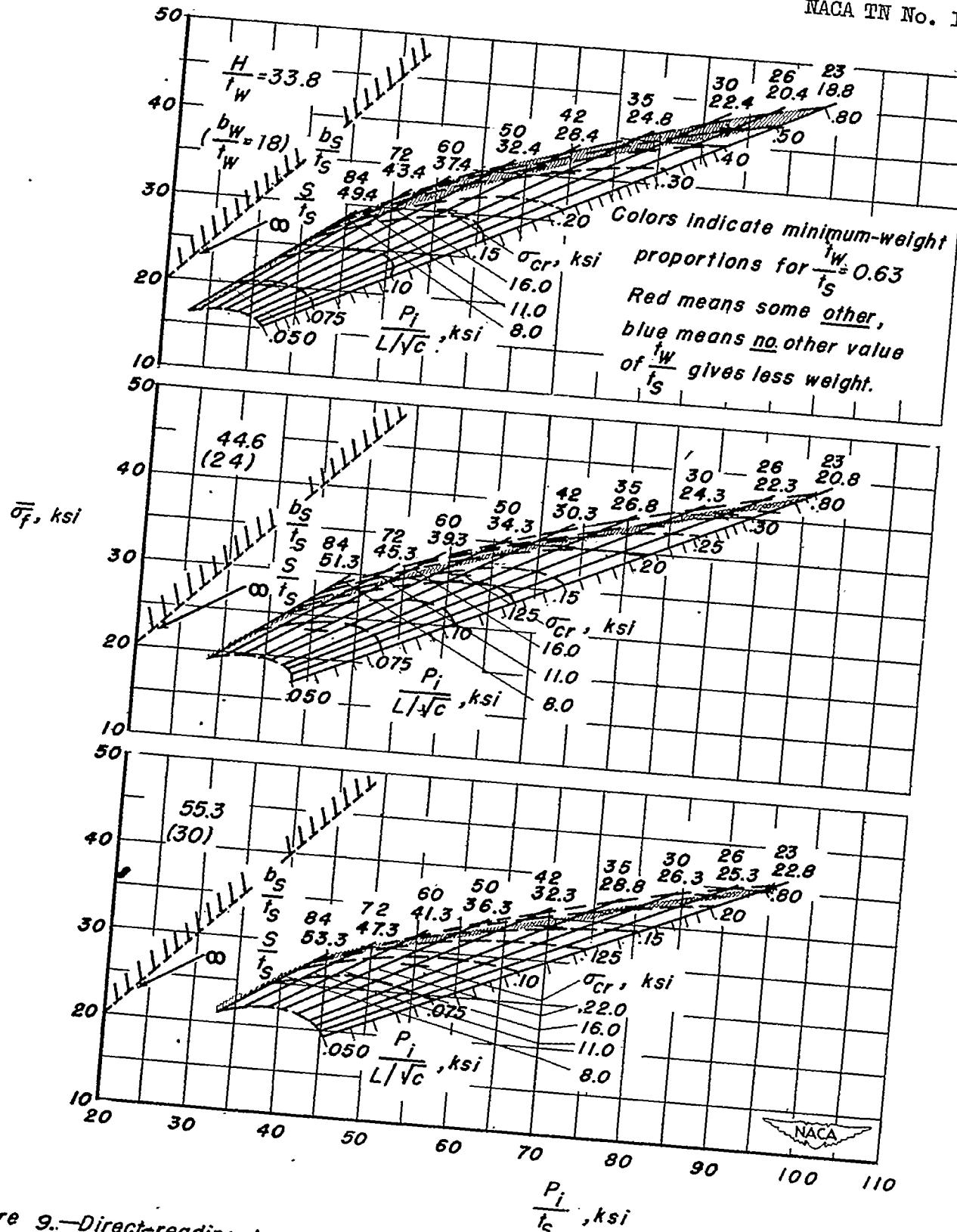


Figure 9.—Direct-reading design chart (alternate form) for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners. $\frac{t_w}{t_s} = 0.63$.

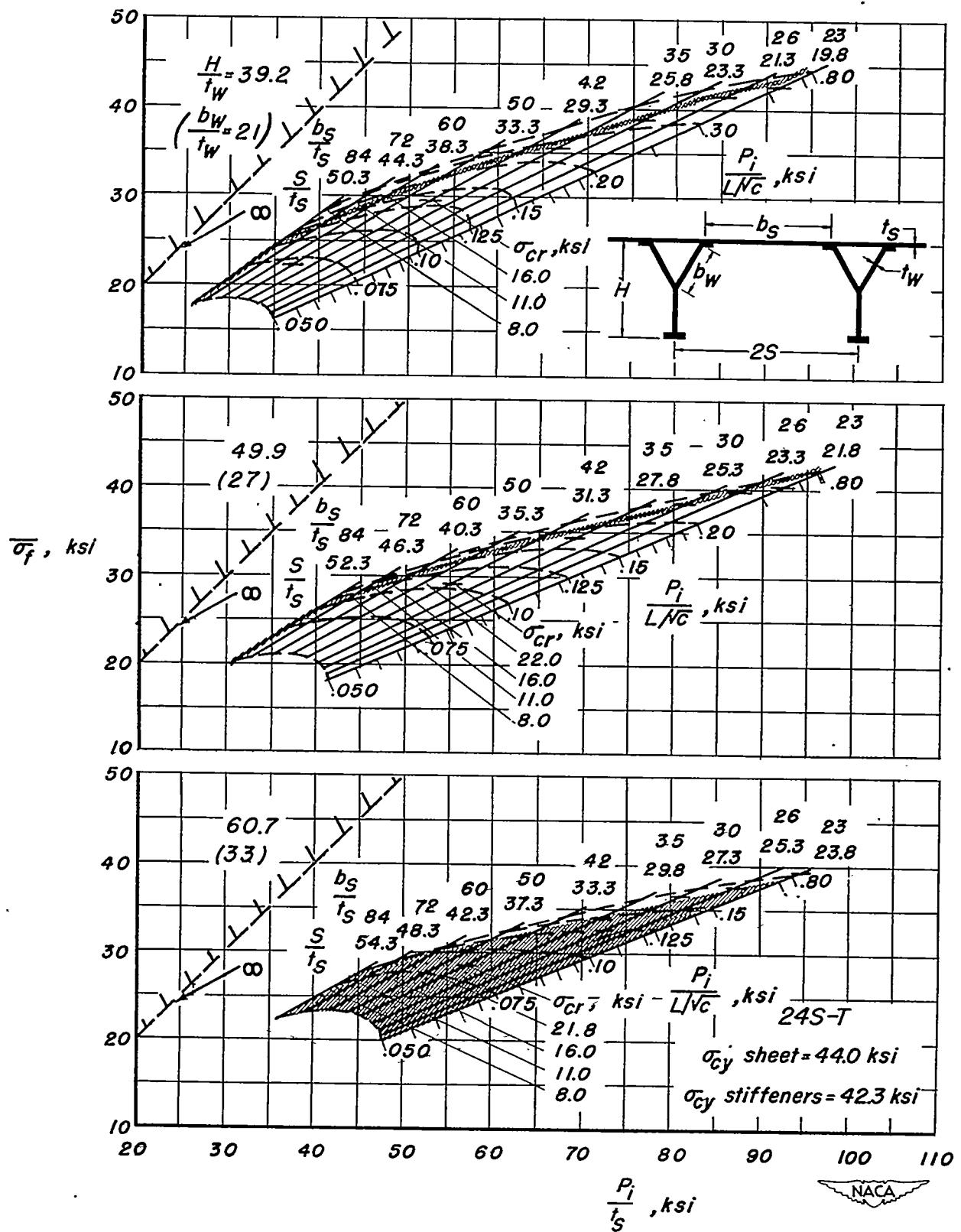
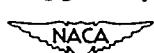


Figure 9.—Concluded. $\frac{t_w}{t_s} = 0.63$.



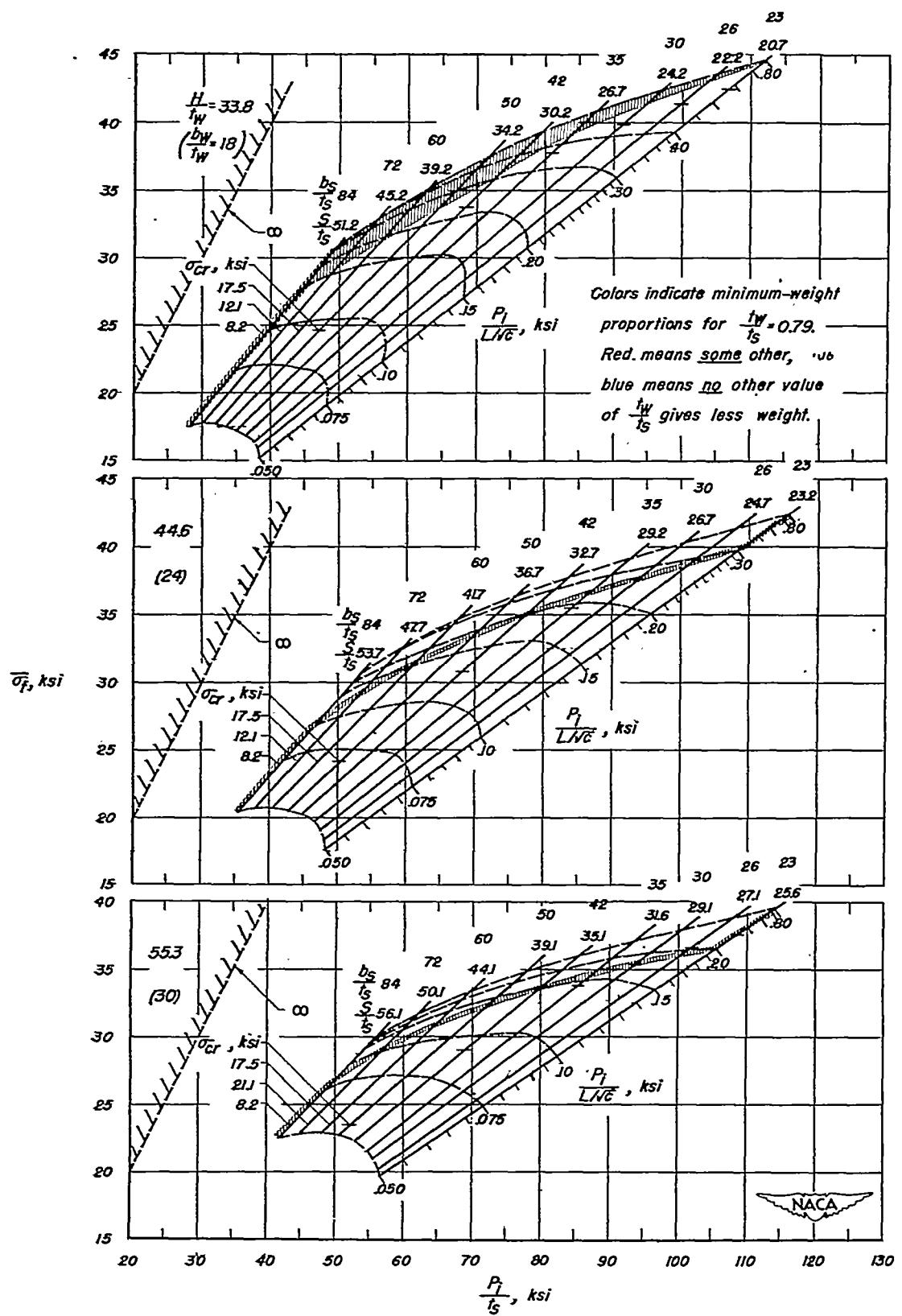
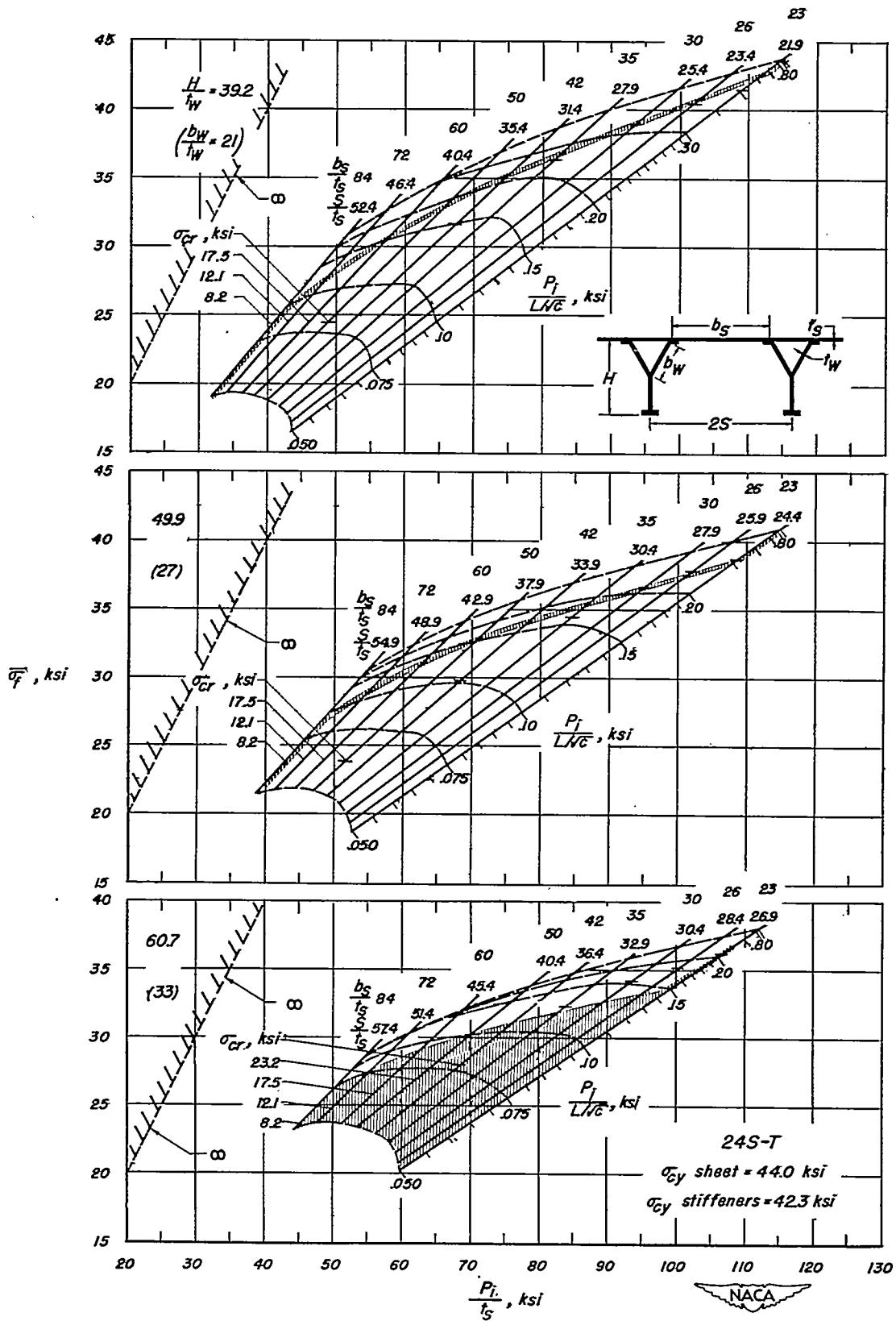


Figure 10.—Direct-reading design chart (alternate form) for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners. $\frac{t_w}{t_s} = 0.79$.

Figure 10.—Concluded. $\frac{t_W}{L} = 0.79$.

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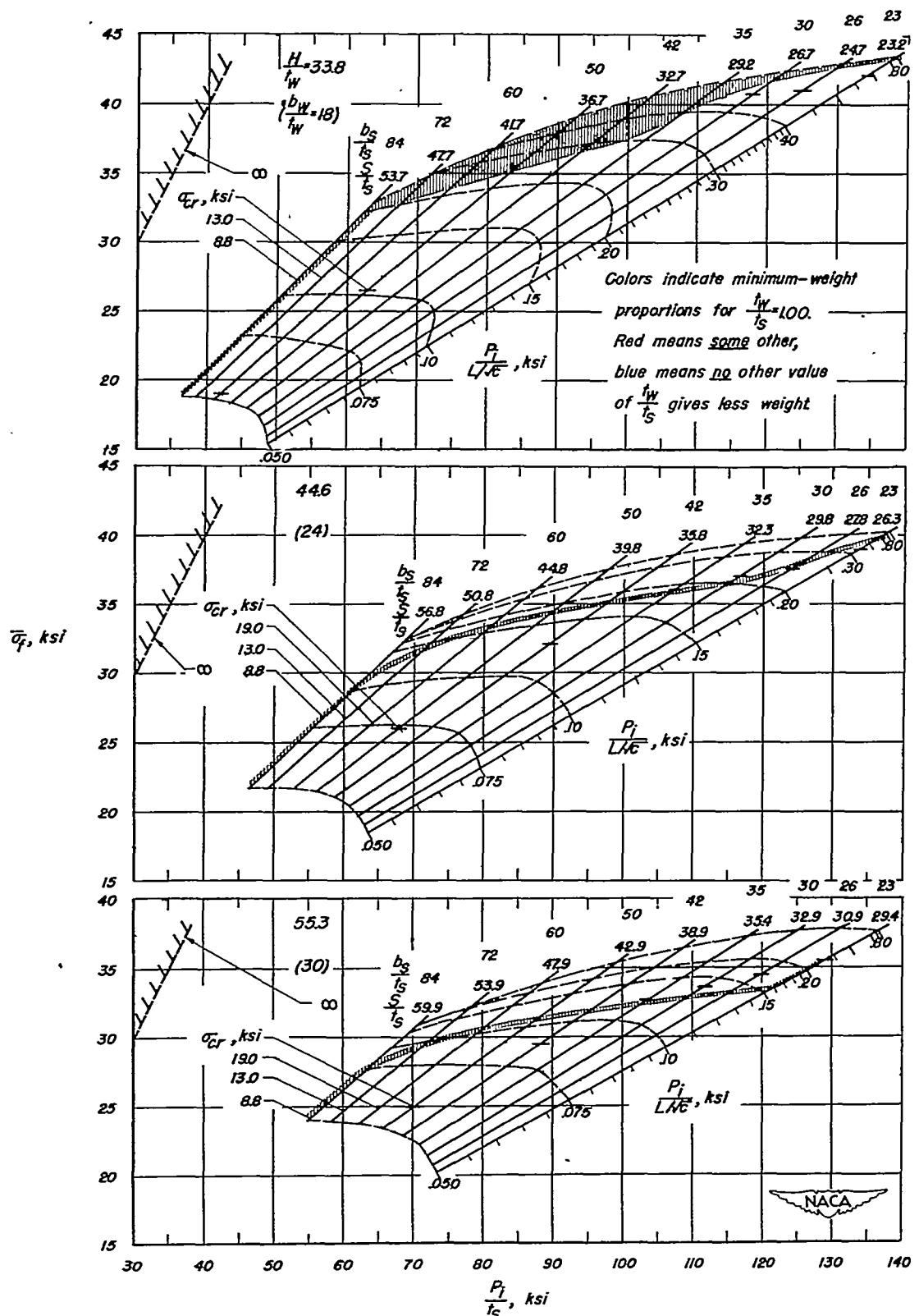
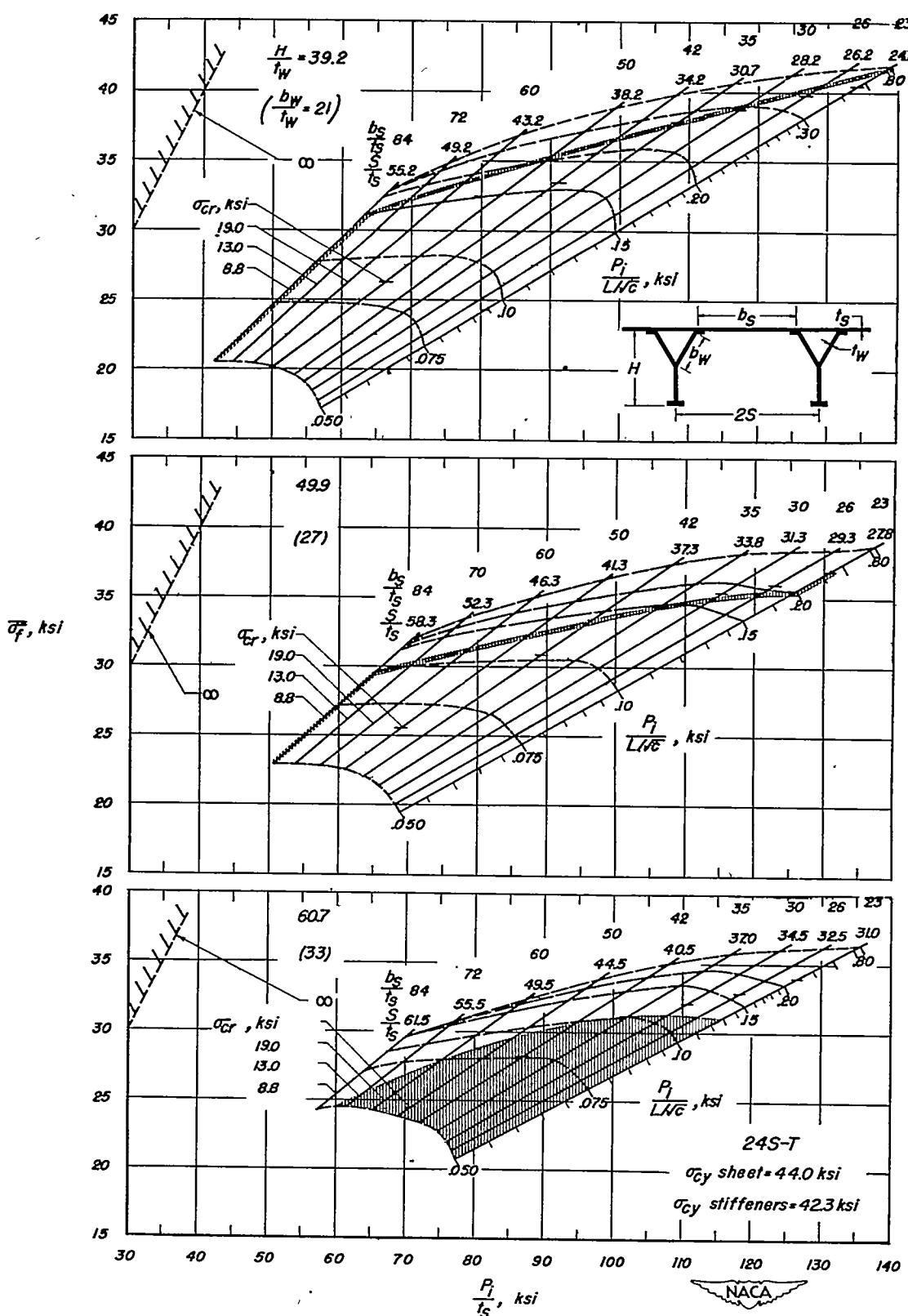


Figure 11.—Direct-reading design chart (alternate form) for flat compression panels of 24S-T aluminum alloy with straight-web Y-section stiffeners, $t_w/t_s = 100$.

Figure 11.-Concluded. $\frac{t_w}{t_s} = 1.00$.

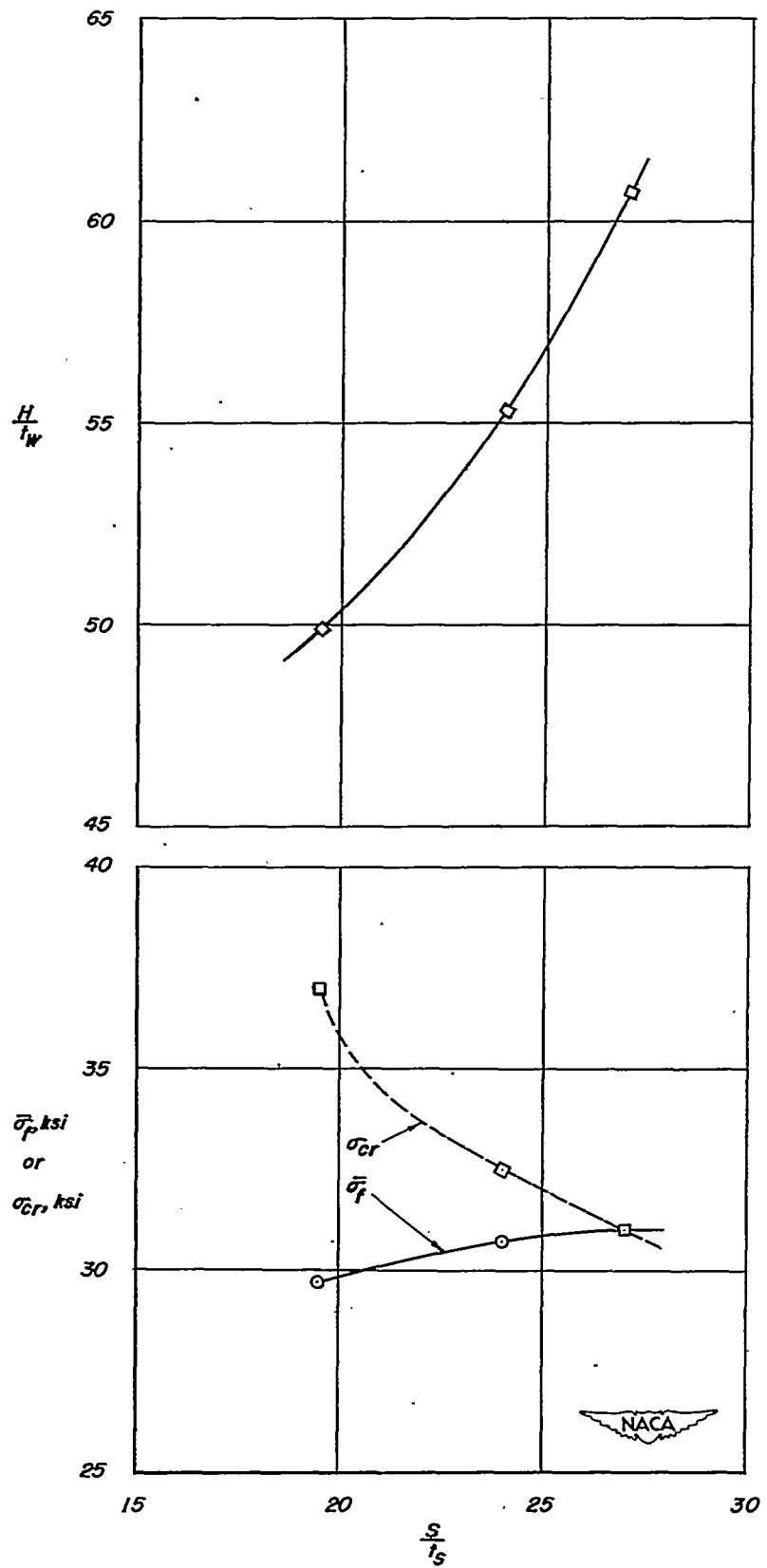


Figure 12.- Plot for obtaining design from design charts.